



# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR

Howard P. Doub, M.D.  
Detroit, Michigan



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## Tropical Diseases of Interest to the Radiologist<sup>1</sup>

LT. COMDR. L. H. GARLAND, M.C., U.S.N.R.

TROPICAL diseases have been defined as diseases which occur or tend to be more prevalent in tropical and subtropical zones. As a result of modern methods of transportation, however, and the present world conflict, they are seen with increasing frequency in temperate areas. Some of the major factors influencing their usual locale include special climatic conditions essential for the existence of the intermediate hosts or vectors often required for their transmission to man, poor local sanitation, and primitive living conditions. The return of large numbers of infected military and civil personnel from endemic areas may result in a significant incidence of the diseases in this country. In this connection it is well to remember that only three decades ago malaria was a common disease in the United States; typhus is still a common disease in Europe; and cholera and yellow fever are only two generations away as a commonplace in subtropical latitudes.

In the present résumé we will attempt to consider the more significant diseases in the approximate order of their present clinical importance in this country, and will also make brief reference to certain diseases not strictly tropical in nature, but of suffi-

ciently greater incidence in some tropical and semitropical areas to warrant consideration here.

### MALARIA

Malaria is probably the most important world-wide disease today (1) and is undoubtedly the major medical problem of the present world war. As has often been noted, "it accelerates the decline of nations and vanquishes more soldiers than the enemy" (2). The radiologist is concerned with the disease in this country chiefly as an additional factor for consideration in differential diagnosis. He must recollect that it can mimic a host of diseases involving different organs of the body, resulting in symptoms which may cause a patient to be referred for x-ray examination of almost any region. Most of the victims of malaria can recognize its diverse manifestations and diagnose its recurrences independent of the physician. Some, however, are unaware that they have the disease or may fail to give a history of infection, and such patients can present themselves with any of the following symptoms, precipitated by fatigue, exposure, surgical procedures, and various lesser vicissitudes:

- (a) Atypical febrile illness, resembling tuberculosis or typhoid.
- (b) Delirium or convulsions (due to cerebral involvement).
- (c) Abdominal pain, simulating appen-

<sup>1</sup> From the Department of Radiology, U. S. Naval Hospital, Oakland, California. The opinions and views set forth in this article are those of the writer and are not to be considered as reflecting the policies of the Navy Department.

Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

dicitis, cholecystitis, and even intestinal obstruction.

- (d) Diarrhea (malarial dysentery).
- (e) Pulmonary disturbances, such as bronchitis and pleurisy.
- (f) Nephritis and hematuria, including blackwater fever.
- (g) Miscellaneous and bizarre disorders of other organs or parts of the body.

The diagnosis must be suspected in order to be made and requires the finding of Plasmodia in the blood smear for confirmation. *Plasmodium vivax* (causing benign tertian malaria) is the most widely found organism. *P. falciparum* (causing malignant tertian or subtertian malaria) is probably the most serious one. The two other and less common etiologic agents are *P. malariae* (causing quartan malaria) and *P. ovale* (causing mild tertian malaria).<sup>2</sup> Mixed infections may occur. Transmission is usually by one of the various species of anopheline mosquitoes.

The radiologist may be asked to examine the abdomen or urinary tract of any patient, in which event he should always note the presence of an enlarged spleen. We have seen three instances in which a correct diagnosis of malaria was first suggested by such notation, the patients being unaware of the infection or the splenomegaly. Needless to say, there are many other diseases in which splenomegaly occurs, but its presence in an obscure case should always lead to an appropriate blood study.

When may the spleen be considered to be enlarged? The spleen normally varies in size in different individuals, and from time to time in the same person; therefore, only fairly definite degrees of enlargement may be diagnosed with certainty. Despite

this variation, the roentgen estimation is inevitably more accurate than the clinical, especially when uniform technical factors are adhered to. In healthy young adult males, examined supine, with a 36-inch target-film distance, the average length of the spleen shadow is 12 cm. and the average breadth 6 cm. The length is measured in a slightly diagonal fashion, from the upper to the lower pole, and the breadth at right angles to this line, in approximately the mid-part of the organ. The breadth may differ considerably from one pole to the other and must often be approximated. The length varies normally in different individuals from 8 to 16 cm. and the breadth from 4 to 9 cm. In about 15 per cent of persons the spleen shadow will be obscured or indefinite in outline; additional procedures, as fluoroscopic examination, with or without air-filling of the colon or stomach, will help in such instances. Enlargement can be diagnosed with reasonable certainty when the spleen measures *over 17 cm. in length or (when its length is within the 12 to 16 cm. range) over 9 cm. in breadth.* Associated roentgen findings include depression of the splenic flexure of the colon, depression of the left kidney, and elevation of the left side of the diaphragm. It is rarely necessary to resort to thorotrast lienography.

The inverted U-shaped spleen is an occasional but rare source of complexity in measurement.

We made serial examinations of the spleens in a group of cases of malaria (chiefly *vivax*) in males of eighteen to forty-five years, all with infections of less than two years' duration. The size of the spleen could be readily determined in 85 per cent of them and therefore we believe that the method should be used whenever exact determinations are considered necessary (Table I).

Aside from splenomegaly and, in some cases, hepatomegaly, the only notable roentgen findings reported in this disease are cerebral calcifications. These may develop in severe chronic cases, especially in *falciparum* malaria. They occur in the

<sup>2</sup> The National Research Council and the Surgeons General of the Army, Navy and Public Health Service are reported (J. A. M. A. 123: 1052, Dec. 18, 1943) as urging the etiologic terminology for the four malaria infections of man: *vivax* malaria (instead of tertian or benign tertian); *falciparum* malaria (instead of estivo-autumnal, subtertian, malignant tertian, tropical, or pernicious malaria); *malariae* malaria (instead of quartan malaria); and *ovale* malaria.

TABLE I: X-RAY MEASUREMENTS OF SPLEEN SIZE

The figures presented here were obtained in a series of 32 cases of malaria, chiefly *virax* infection. Measurements are recorded in centimeters, directly from films made at 36-inch target-film distance, with the subjects supine. The examinations were repeated at least once in each case, as part of an investigation conducted by Lt. Comdr. D. L. Wilbur (MC) USNR, on the effect of a certain mechanical treatment on malaria.

X-Ray Number	Size at 11 A.M.	Size at 3 P.M.*	Notes
5414	15 × 8	15 × 9	...
4473	19 × 7	19.5 × 7	May 1
4473	21 × 12	22 × 12	June 1
6287	12 × 4	11 × 5	...
6276	15 × 5	15 × 5	...
5939	25 × 6	25 × 6	...
5273	12 × 4	12 × 4	...
5254	16 × 11	16 × 10	...
5452	12 × 3	12 × 3	...
5449	12 × 3	12 × 3	...
5431	13 × 4	13 × 4.5	...
5418	10 × 4.5	10 × 4	...
5428	19 × ?	19 × ?	...
5427	11 × 5	13 × 5	...
3452	23.5 × 7	23.5 × 7	May 8
3452	23.2 × 7	23.2 × 7	May 15
2412	13 × 5	13.5 × 5	...
4618	17 × 4	16 × 5	...
4777	16.5 × 5	16 × 5	...
4673	20.5 × 6	22 × 6	May 25
4673	22 × 6	22 × 6.5	May 26
5319	14 × 7	14 × 7	...
5307	15 × 5	16 × 5	...
5303	17.5 × 6	17 × 6.5	...
5283	14.5 × 4.5	16 × 5	...
5281	23 × 7	23 × 7	...
5277	17.5 × 7	17.5 × 7	...
5157	18 × 7	19.5 × 7	...
5148	13.5 × 5.5	13.5 × 6	...
5101	21 × 5.5	21 × 5	...
2187	19 × 6	19.5 × 6	...
4976	11 × 4.5	? ?	Second film unsatisfactory
3228	17 × 6	15.5 × 6.5	...
3924	13 × 5	11.5 × 5	...
5131	18 × 7	16.5 × 6	...

\* The afternoon measurements were made following a mechanical "respirator" treatment which was reported to produce, among other benefits, shrinkage of enlarged spleens. It is apparent from the above figures that no such effect took place in our cases. The "treatment" was not pursued.

hemorrhagic or granulomatous subcortical lesions (3). We made roentgen examinations of the skull in a small number of cases of cerebral malaria and in a larger group of cases of chronic malaria, none of them of over three years' duration; we did not find calcifications in any instance. Differential diagnosis would have to include the numerous other calcifying parasitic, inflammatory, and degenerative disorders of the brain.

#### DENGUE

Dengue may come to the attention of the radiologist because of a request for x-ray examination of the bones and joints. Patients usually show a high fever, severe

pains in joints and muscles, and leukopenia. Some have, also, a rash and adenopathy. Many have pain referred to the eyeballs. The disease is due to a virus transmitted by the *Aedes* mosquito. There are no characteristic x-ray findings.

#### DYSENTERY

*Bacillary Dysentery:* This disease, due to various species of *Shigella*, is of widespread distribution and may result in serious epidemics. In the acute stage, there are no findings of specific radiological interest. In the chronic stage, x-ray changes resembling those of chronic ulcerative colitis have been reported.

*Amebic Dysentery:* This form of dysen-

tery, due to *Endamoeba histolytica*, is also world-wide in distribution, but is more prevalent in tropical than in temperate regions. It may be acute or chronic; carriers are common. The chronic form sometimes shows features of radiologic importance:

(a) Colon: Irritability and mucosal irregularities, especially in the proximal half of the large bowel, and occasional hyperplastic changes in the cecum and appendix are observed. Some believe that cecal inflammatory changes without pulmonary disease should suggest amebic colitis. Bell (4) reported conical spasm of the cecum, with segmental irritability of the colon in a group of cases.

(b) Liver: Enlargement of one or other lobe, with associated displacement of the colon or stomach, may be due to liver abscess. We have found this observation of gastric displacement of considerable value in two cases of amebic abscess of the left lobe of the liver. These abscesses may be single or multiple and sometimes attain enormous size. Thorotrast hepatography may help in their localization.

(c) Lung: Abscess of the lung, silent or otherwise, may occur, often by extension from a liver abscess. There are no pathognomonic x-ray findings.

(d) Miscellaneous: Abscesses of the brain and other viscera are occasionally seen.

#### TYPHUS AND OTHER RICKETTSIAL DISEASES

The rickettsial diseases, while of considerable clinical importance, present no roentgen findings of immediate interest, with the possible exception of Q fever. In that disease, due to *Rickettsia diaporica* or *burneti*, a patchy type of bronchopneumonia, confined to one lobe, has been reported.

Scrub typhus or tsutsugamushi disease is often followed by myocardial disturbances. We are at the present time making cardiac roentgen studies on a series of patients convalescent from this disease, and hope to report these (along with the results of kymographic observations) in a subsequent publication.

#### CHOLERA, YELLOW FEVER, PLAGUE, AND THE RELAPSING FEVERS

Cholera, yellow fever, plague, and the relapsing fevers have no features of outstanding radiologic interest. The pneumonic type of plague is rare and usually too fulminating to permit or require x-ray studies.

#### LEPTOSPIROSES

The most important of the leptospiroses is Weil's disease, due to *Leptospira icterohaemorrhagiae*. Jaundice and hepatomegaly are seen.

#### HELMINTHIASIS

Helminthiasis includes a large group of disorders, many of them non-tropical in nature. Only the more important ones, which show some findings of radiologic importance, will be considered here.

*Hookworm disease* is usually due to *Necator americanus* or *Ankylostoma duodenale*. In the former type, small bowel changes similar to those seen in deficiency disorders have been reported (5). They may subside following vermifugation. Patients with ankylostomiasis may have symptoms of duodenal ulcer, caused by presence of numerous hooklets in the duodenal bulb, with associated duodenitis (6). The thickening of the mucous membrane, irritability, and local tenderness disappear soon after administration of a vermifuge. We have seen only one case with such findings.

*Strongyloidiasis*, due to *Strongyloides stercoralis*, usually results merely in diarrhea. However, changes in the small bowel suggesting regional ileitis, and in the lungs (localized infiltrates), have been reported (7).

*Ascariasis* is the commonest helminthic infection. The worms may be recognized in the course of a gastro-intestinal examination as radiolucent shadows, occurring especially in the jejunum. They measure from 15 to 30 cm. in length and about 6 mm. in diameter. The gastro-intestinal tract of the worm itself may be outlined with the host's barium at a twelve or twenty-four hour study. Occasionally, a

bolus of worms causes intestinal obstruction.

It is of interest to note that the actual incidence of intestinal parasitism in naval personnel returning from the Pacific theatre in the years 1942 and 1943 was quite low, according to Michael (8), who published a brief table showing the percentage distribution of the conditions at that time.

#### TRYPANOSOMIASIS

There are two completely different forms of trypanosomiasis, the African and the American. African trypanosomiasis, due to *Trypanosoma gambiense* or *Trypanosoma rhodesiense*, causes sleeping sickness, with its associated hepatosplenic enlargement. American trypanosomiasis, due to *Trypanosoma cruzi*, causes Chagas' disease, with acute or chronic cardiac disturbances. The African type constitutes, of course, the greater health problem. No important or characteristic x-ray changes have been reported.

#### LEISHMANIASIS

Leishmaniasis, due to a minute parasite, *Leishmania*, may be predominantly visceral or cutaneous. The former type, or kala-azar, is characterized by fever, anemia, and hepatosplenic enlargement. It may be mistaken for malaria. Its complications are numerous and frequently severe: they include pulmonary, intestinal, and vascular disturbances. Cutaneous leishmaniasis appears in two forms: the oriental and the American. Both show ulcerating granulomas of the skin, especially of the face and upper extremities. The American type, or espundia, shows mucosal lesions as well. It is common in South America.

#### FILARIASIS

Three different forms of filariasis are seen in man, the most important being that due to the minute worm formerly known as *Filaria bancrofti* but now by the cumbersome title *Wuchereria bancrofti*. This is the most widely distributed of the filarial diseases, being spread by various types of mosquito, notably of the genus *Culex*.

*Filariasis.* Filariasis due to *Wuchereria bancrofti* and to *W. malayi* is of considerable interest to radiologists, both from the point of view of diagnosis and treatment. The incubation period varies from three to more than twelve months. In otherwise healthy adult white males, not subject to heavy or repeated infection, it may present few or no clinical symptoms. When symptoms are present, they usually consist of periodic attacks of superficial lymphangitis involving an arm or leg, with variable degrees of lymphadenitis. The lymphangitis is frequently "retrograde," extending distally from the point of initial development. Attacks of funiculitis, epididymitis, and orchitis commonly occur. Hydrocele or serotal edema may develop. These attacks of lymphangitis may be mild or very painful. They usually subside in a week or two and may not recur for months or years. Some cases show repeated recurrences at short intervals. Edema, wheals, and other allergic phenomena occur.

After several attacks of lymphangitis, persistent edema and fibrosis may develop and the condition of elephantiasis appear. This usually takes several years and seems to occur chiefly in those with prolonged exposure, massive infection, or complicating pyogenic infection. In the late stages, chyluria, chylous ascites, and chylous diarrhea may occur. Chyluria (probably better known as lymphuria) is due to rupture of dilated blocked lymphatics into the renal pelvis or ureters. If blood vessels rupture along with the lymphatics, hematomphuria results. Some patients show no symptoms; others experience weakness, abdominal pain, and depression. The deformity of the renal pelvis produced by the dilated lymphatics has been correctly diagnosed by urography.

In some patients the worms die and become calcified, producing small opacities, especially in the subcutaneous tissues, lymph nodes, and the scrotal lymphatics. These appear as small linear or dot-like shadows from 1 to 4 mm. in length and only about 1 mm. in diameter. Some observers have reported opacities up to 12



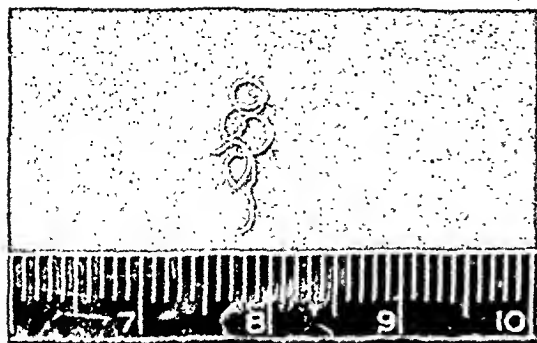


Fig. 1. *Wuchereria bancrofti* (female) from a case of filariasis in a male of twenty-six who had an infestation of about eighteen months' duration. Worm photographed in a Petri dish containing normal saline. Recovered from an enlarged left inguinal node, which was incised and placed in warm saline solution for about forty-eight hours; at the end of that time the worm had wriggled free of the node. Clinical symptoms were intermittent painful lymphangitis in left arm and left leg, and funiculitis. Courtesy of Lt. Comdr. D. L. Wilbur.

mm. in length (9). They are often difficult to recognize but are fairly characteristic, having a different distribution than calcified *Trichinae*, and being much smaller than *Cysticerci* (10). We have made roentgenograms of the extremities and scrotal areas in over fifty cases of filariasis in white adult males, all with infections of less than two years' duration, without succeeding in demonstrating calcified worms in any one of them. The worms are said to live from one to seven years and in our cases probably few were adequately calcified, even if dead, in the short time elapsing since infection. The female worm measures up to 6 cm. in length and 0.25 mm. in thickness; the male is about half that size. They are often found coiled up in a node and occasionally in a thickened lymphatic. They have been recovered alive from excised nodes, by immersion of the node in warm saline for a day or two (Fig. 1).

It is to be noted that the outstanding symptom and sign of filariasis is lymphangitis, and that the microfilariae are rarely discovered in the blood in the early stages of the disease, at least in current cases of *W. bancrofti* infestation arriving from the South Pacific area. Diagnostic skin tests are under investigation, but no really satisfactory test has yet been reported. Some authorities regard biopsy

of involved nodes as inadvisable because of a tendency to initiate recurrences. A reliable skin test may therefore be all the more desirable.

In those patients who have significant pain, soreness, or other disability associated with the attacks of lymphangitis or lymphadenitis, considerable palliation and even actual arrest of an attack can often be obtained by irradiation of the involved areas. We use small doses administered to wide fields (from 50 to 100 r, in air, with fields not less than  $20 \times 20$  cm.), with moderate filtration, half-value layer equivalent to about 0.5 mm. copper. This dose is given to the involved regions every three days for about four doses. The treatment occasionally causes a temporary accentuation of symptoms for about twenty-four hours and may induce a brief abortive attack in a previously quiescent area.

Others (11, 12, 13) have also reported favorable results in the treatment of this condition by radiation. Burhans and Camp (11) used doses of about 75 r repeated every second day for three doses; they reported that recurrences were fewer in the treated areas and that many of their patients were able to resume sustained physical work, though such efforts prior to x-ray treatment invariably induced recurrences.

Golden and O'Connor (12) reviewed the literature on the x-ray treatment of filariasis up to 1934 and also reported a group of their own cases. They made some interesting histological observations on worm-containing tissues excised subsequent to irradiation. In these "the appearance of the dead calcifying worms was quite different from that of similar worms in unirradiated tissue; giant cells in the vicinity of the irradiated worms were much more numerous, calcification of the parasites was in many instances limited to the cuticle instead of extending through them, fibrosis around them was composed of younger cell forms and was surrounded by areas of marked round cell infiltration, whereas under ordinary conditions the fibrous tissue includes areas of hyalinisa-

tion and the round cell infiltration is relatively slight."

Commenting on the results of treatment, Golden and O'Connor observed that appraisal is difficult (a) because attacks of lymphangitis often subside spontaneously for no obvious reasons, even under unfavorable circumstances, and (b) attacks which were once frequent may spontaneously become very infrequent, not recurring for several years, without any treatment. In our own experience, about 75 per cent of cases showed benefit from x-ray treatment, some of the most spectacular results being in those with very painful attacks. We would not, however, claim cure or permanent arrest in any.

Yamaguchi (13) has reported successful results in treating filariasis with total-body irradiation. He gave courses of from 11 to 22 treatments and believed that he depressed the reproductive mechanism of the worms. He also noted immediate reduction in lymphatic induration and swelling. We have not used total body irradiation in any cases.

The late complications of the disease, such as lymphuria, have also been treated with apparently excellent results. Golden (12) reported a group of cases of chyluria treated by irradiation of the kidneys. He used doses of 50 to 75 r weekly for four to fifteen doses, usually with a rest of a month or two after four doses had been given. The usual technical factors (200 kv., filter of 0.5 mm. copper and fields 20 × 20 cm.) were employed. The cases were followed for one to three years; in all of the 7 treated, the chyluria ceased during treatment; 4 patients remained well for periods as long as three years; there were 2 recurrences and one death from accidental causes soon after treatment terminated.

*Onchocerciasis* and *Loiasis* are two types of filariasis less common than the above. *Onchocerciasis* is due to *Onchocerca volvulus* (the blinding filaria). Patients show tender subcutaneous nodules, especially on the head, and sometimes keratitis and blindness. An itching lichenoid dermatitis may



Fig. 2. *Dracontiasis*. Calcified guinea-worm (*Dracunculus medinensis*) in the leg of an adult male. In other sites, such as the thoracic wall, the worm may be coiled up and appear as a localized calcific opacity. From Beal (14).

develop. The condition is seen in West Africa and Central and South America. *Loiasis* is due to *Filaria loa loa*. The patients have subcutaneous swellings, and the parasite may migrate to the subconjunctival tissues. It is to be noted that the "blinding" filaria causes intrinsic eye changes due to migration of microfilariae into the eye structures, while the *Loa loa* merely causes temporary inconvenience (when the worm passes across the subconjunctival tissues—a rather striking episode, well recorded in colored motion pictures).

*Dracontiasis* is due to *Dracunculus medinensis*, the guinea-worm, formerly classified as *Filaria medinensis*, and for that reason considered in this section. The male worm is about 2 cm. in length, and the female from 15 to 100 cm.! Each measures from 1 to 2 mm. in diameter. They may produce no symptoms until the skin over them is punctured, usually at the

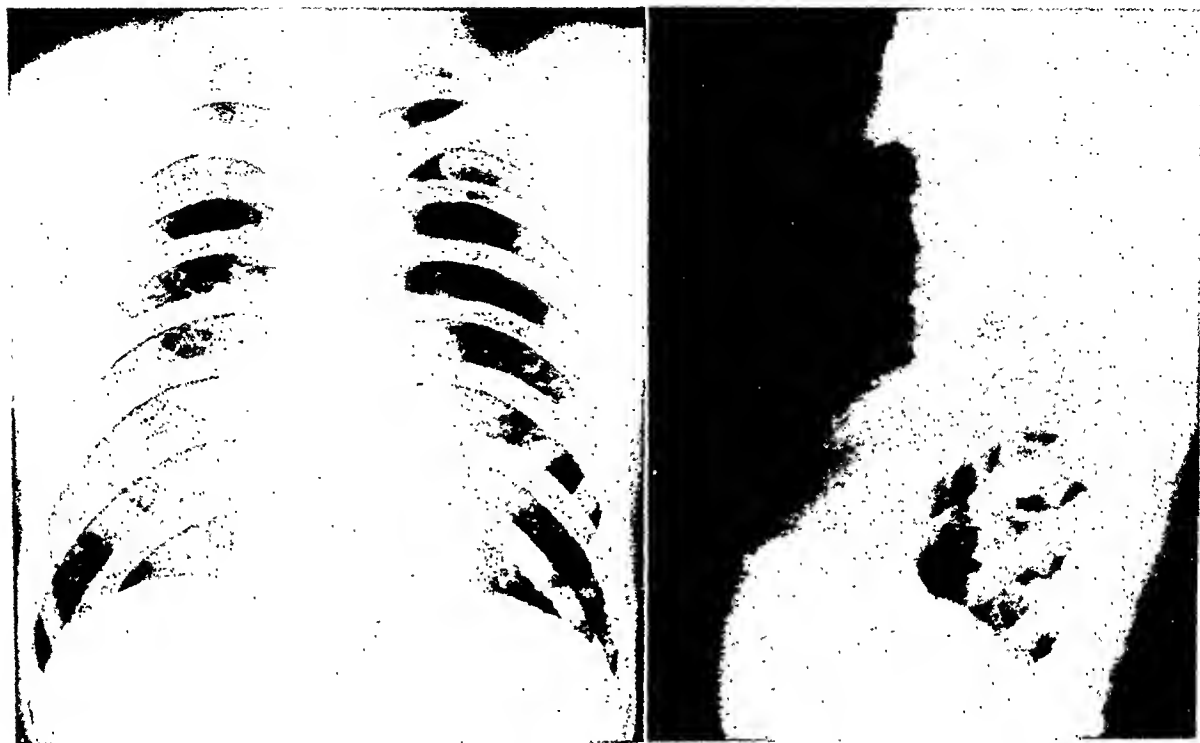


Fig. 3. Paragonimiasis (pulmonary distomiasis due to *Paragonimus westermani*). Accentuation of the basal pulmonary markings (? pneumonitis), especially on the right side. The patient was a male, aged twenty-four, with hemoptysis, cough, weakness, and pain in the lower chest for about six months. Symptoms developed after four months of jungle training in British Samoa. Sputum negative for acid-fast organisms and positive for ova of *P. westermani*. Patient also had pain in the left leg and groin with transitory cutaneous ulcers. Roentgen examination of the bones and soft tissues of these areas was negative. The clinical course was one of slow improvement.

point of emergence of the head. If retained after it dies, the worm often calcifies and appears as a segmented, linear, or coiled shadow. Beal (14) and others have reported the occurrence of these calcified worms in the leg, chest, and abdomen. Their large size renders them readily recognizable, their favorite location being in the subcutaneous tissues of the leg (Fig. 2). Castay (15) has reported them in the scrotum, the posterior thoracic wall, and the left supraclavicular region: in the first two areas they produced changes resembling cold abscesses.

#### DISTOMIASIS

The diseases grouped under the heading distomiasis are due to trematodes or flukes. *Intestinal distomiasis* is due to a variety of trematodes, especially *Fasciolopsis buski*. In cases of this latter type, edema may supervene on prolonged diarrhea.

*Hepatic distomiasis* is due commonly

to *Clonorchis sinensis*. Liver enlargement, jaundice, etc., are seen.

*Pulmonary distomiasis* is due to *Paragonimus westermani*. The worm is actually found in many of the organs besides the lung, but pulmonary symptoms tend to predominate. Ova may be recovered from both sputa and excreta: they are small, brown, and operculated (measuring from 65 to 100 microns in length). The fluke itself measures about 8 mm. in length and 2 mm. in thickness. In chronic cases it causes small cystic lesions in the lungs, with associated inflammation and ulceration. Roentgenograms may reveal nodular thickening of the pulmonary markings, especially in the lower lobes, with variable degrees of bronchiectasis and even cavitation. The concomitant blood spitting gives rise to the term "endemic hemoptysis." Undoubtedly a better term is *paragonimiasis* (16). Four clinical types are recognized: (1) a generalized lympho-

nodular type, with fever, adenopathy, and cutaneous ulceration; (2) a pulmonary type, with cough, chest pain, bloody or purulent sputum, and variable roentgen changes in the lungs; (3) an abdominal type, with pain, tenderness, variable degrees of diarrhea, hepatomegaly, and other findings; (4) a cerebral type, with various convulsive, parietic, or other manifestations. It is reported that in some sections of Japan, cerebral paragonimiasis is included in the routine differential diagnosis of cases of epilepsy.

We have seen 8 cases of pulmonary paragonimiasis in personnel returning from the South Pacific area and have made complete roentgen examinations of the lungs in all of them. Only 2 showed significant degrees of nodular thickening of the basal pulmonary markings, bilaterally. The findings were not in the least diagnostic *per se*, but in conjunction with the history of intermittent cough and hemoptysis plus appropriate exposure, they were of some value in diagnosis (Fig. 3). In all 8 cases, the eggs were found in the sputa. None showed gross bronchiectasis, nor were the "shadows of the fluke" ever visible in any of the films. Miller and Wilbur (17) have described in detail the clinical features of 3 of these cases and are responsible for bringing our attention to this unusual condition. In two of their patients severe and persistent thrombophlebitis of the legs was present. In none were cerebral symptoms prominent.

*Schistosomiasis* is due to a group of blood flukes. Three types are seen in man: bilharziasis or endemic hematuria, due to *Schistosoma hematobium*; rectal or intestinal bilharziasis, due to *S. mansoni*; oriental schistosomiasis, due to *S. japonicum* (with which type liver symptoms predominate).

In infested countries, a high percentage of the population is afflicted with bilharzia (native involvement running up to 60 per cent). The mode of infection is through an abrasion in the skin. All organs of the body are affected, the genito-urinary and gastro-intestinal tracts being the most com-



Fig. 4. Bilharziasis. Calcified ova in submucosal tissues of bladder and ureters, in an adult male with urinary bilharziasis, due to *Schistosoma hematobium*. Note the faint calcific streaks in portions of the ureteral walls. From Ragheb (18).

monly and most severely involved. The clinical diagnosis is said to be simple, the principal symptom being bleeding from the urinary or gastro-intestinal tract. The diagnosis is confirmed by finding the ova in the excreta. The ova are deposited in the submucosa, giving rise to ulceration and subsequent calcification, which can be shown roentgenographically. Two forms of reaction are seen: calcific streaks in the walls of involved areas; oval densities like stones or calcified papillomata.

The first form is predominant in the bladder and ureters. The second form is found commonly in the intestines and the kidneys. Papillomas in the intestinal tract are not usually calcified, except in the region of the appendix. Those occurring in the kidneys are usually calcified, causing shadows which resemble stones. The calcifications in the urinary tract are fixed in position and may not increase in size even in the course of years. They do not en-



Fig. 5. Cysticercosis. Calcified cysticerci in the skeletal muscles of a male, aged thirty-eight. This patient also had calcified cysts in the soft tissues of the neck, the thoracic wall and the abdomen. His approximate date of infestation was fifteen years previously. Autopsy proof. Note: The calcified cysticerci often vary greatly in shape and size. They may be oval, circular or triangular in shape, from 0.2 to 5 mm. in diameter, and from 0.2 to 20 mm. in length. In the brain they tend to be small and spotty (from 1 to 3 mm. in diameter). From Brailsford (21).

croach on the lumen, as they are embedded in the mucosa. The calcified papillomas are readily seen roentgenographically, the uncalcified ones by the aid of opaque media. The bladder (Fig. 4) is usually the first organ to show evidence of disease (18).

Cases of pulmonary nodulation, due to ova or adult worms reaching the lungs, and resembling miliary tuberculosis, have been reported in both the urinary (*S. hematobium*), and the intestinal (*S. mansoni*) forms of the disease (19, 20).

#### TENIASIS

This group of diseases is due to cestodes or tapeworms.

*Diphyllobothrium latum*, the broad tapeworm, causes few serious symptoms except anemia. It measures from 2 to 10 meters in length.

*Taenia solium*, the pork tapeworm, causes variable symptoms, usually mild. It measures about 2.5 cm. long. Its larval form, *Cysticercus cellulosae*, causes *cysticercosis*. Cysticercosis is usually acquired by eating "measly" pork and may be associated with serious symptoms. The larvae may occur in any organ in the body, but especially in the brain and eye, and symptoms vary accordingly. In the brain, they may cause epilepsy; in the eye, visual aberration; in the muscles, rheumatism, etc. When calcified, which rarely occurs until at least five years after infestation, the larvae become visible on roentgenograms. In the brain they show as small opacities, 1-3 mm. in diameter, scattered through the substance of the organ. In the muscles (where they are much more apt to become calcified than in the brain) they usually appear as ovoid densities, about  $2 \times 10$  mm., lying in the direction of the muscle fibers (Fig. 5). They range in number from one to several thousand in a single patient, and may vary greatly in size and shape (21, 22). In the differential diagnosis of brain lesions, tuberculous sclerosis may be considered but does not show any associated skeletal muscle calcifications. There are other unusual inflammatory and degenerative cerebral conditions in which patchy calcification occurs, but space does not permit their consideration here. In the differential diagnosis of muscle calcification there is usually little difficulty: in trichinosis the calcified areas are only about 1 mm. in diameter; in calcinosis interstitialis they are usually linear and diffuse.

*Taenia saginata*, the beef tapeworm, occurs in man only in adult form and is not associated with any specific findings of immediate interest.

*Taenia echinococcus* (now known as *Echinococcus granulosus*), the dog tapeworm, occurs in man only in its larval form, causing hydatid disease or *echinococcosis*.

While not strictly speaking a tropical disease, this condition occurs sufficiently often in persons returning from overseas (especially Australia and Iceland) to be worth considering here. The echinococcus or hydatid cyst is formed by liquefaction of the larva after it has invaded the tissues. It grows slowly and its wall is composed of two layers, an external laminated cuticle and an internal germinative layer, a fact of diagnostic value in some pulmonary hydatids (23). The cysts may be simple or complex; some are sterile; some become secondarily infected. They may rupture into hollow viscera, such as bronchi, intestinal tract, biliary tree, and urinary tract.

Hydatid cysts occur most frequently in the liver (over 50 per cent of cases.) They also occur in the lungs, pleura, abdominal viscera, bones and, rarely, in the nervous and cardiovascular systems. Some are small and symptomless; others are large and produce serious symptoms. In solid viscera, such as the liver, cysts tend to undergo calcification of their walls, while in non-resistant organs, such as the lungs, they rarely or never do so. In bone, a patchy cystic appearance develops, resembling fibrocystic disease or osteolytic metastatic carcinoma; the ribs and pelvis are common sites. In the brain the diagnosis has been made by aspiration and air filling. In the lungs, well defined circular opacities occur; they may be quite large but usually vary from 3 to 8 cm. in diameter. Bone and lung lesions may co-exist.

#### TROPICAL TREPONEMATOSES

The tropical treponematoses include yaws, pinta, and bejel, all granulomatous diseases due to treponemata, and rarely seen in this country. In the chronic or late stages, lesions of bones and viscera may occur, similar to those seen in syphilis. We have seen one case of yaws in an officer who accidentally infected a finger while in the South Pacific area. He developed a nodular granuloma at the site of inoculation, with regional adenopathy and

a rash; *Treponema pertenue* was found on dark-field study. The lesion regressed promptly with bismuth treatment. In some endemic areas, peculiar tertiary forms of yaws are seen: (a) goundou, a chronic sclerosing osteoperiostitis of the superior maxilla, and (b) gangosa, a destructive ulcerating process of the nose and palate, especially of the cartilaginous portions. Gangosa may also be due in rare instances to cutaneous leishmaniasis. The x-ray appearance of such advanced lesions is readily visualized.

Pinta, due to *Treponema carabeum*, is seen in Cuba, Mexico, and Central and South America. It may result in various visceral lesions similar to those of tertiary syphilis, including aortic aneurysm. There are no characteristic roentgen findings.

#### · TOXOPLASMOSIS

In toxoplasmosis, a rare condition due to a sporozoan, the *Toxoplasma* (probably of the Haemosporidia group), various cerebral and pulmonary lesions of radiological interest have been reported. In infantile toxoplasmosis diffuse cerebral calcifications may occur, in association with symptoms of encephalomyelitis. The calcifications are usually bilateral, vary from 1 to 3 mm. in diameter, and are located in the cerebral hemispheres; curvilinear streaks may be present in the basal ganglia. Areas of demineralization in the diaphyseal ends of the long bones and of pneumonitis in the lungs have been noted. In adult toxoplasma infections, bilateral pulmonary infiltration, of a type similar to that occurring in influenzal pneumonia, may be seen. Lesions of the heart muscle and skeletal muscles (presumably granulomatous infiltrates) are also reported.

#### LEPROSY

Leprosy is largely of academic interest in this country. It is to be remembered, however, that in cases of the neural type, various degrees of concentric atrophy of the phalanges and small bones of the hands and feet are seen. This concentric atrophy may result in spontaneous amputations

and other deformities (24). These are not entirely diagnostic, however, since similar findings are present in some other neurotrophic disorders and in certain peripheral vascular diseases. Rarely, true leprous granulomata occur in the bones; these produce the same roentgen changes as other granulomata.

#### MISCELLANEOUS LESIONS

*Tropical Ulcers:* Various types of tropical ulcers (sloughing phagedena) may be encountered, especially of the feet, hands, and face. These are commonly due to spirochetal and bacillary organisms. They often extend to adjacent bones and joints. X-ray changes are those of a severe infectious osteitis or osteoarthritis. In recent months there have been reports of pathogenic diphtheria bacilli being found in some tropical ulcers and desert sores. These have occasionally been virulent and associated with characteristic paralyses and other symptoms.

*Ainhum* is clinically equivalent to spontaneous amputation of the little toe; it is apparently a neurotrophic disorder. Films show atrophy or disappearance of the phalanges.

*Madura foot*, or mycetoma, is a fungus infection, usually involving the foot and resulting in chronic swelling, ulceration, and sinus formation. The bones and joints show varying degrees of destruction and osteoporosis.

*Acne vulgaris* and *Epidermophytosis*. These quite non-tropical disorders show a tendency to special and severe types of exacerbation under some tropical conditions. Since x-ray treatment is often an important factor in their alleviation or cure, they are mentioned here. They are a prolific source of hospitalization of otherwise healthy young men. Many cases respond promptly to small doses of roentgen radiation (50–150 r), repeated weekly for four to eight weeks.

#### SUMMARY

Some tropical diseases of importance to the radiological consultant are reviewed.

The pleomorphic symptoms exhibited by many of them are stressed.

Two aphorisms well known to clinicians are repeated: "In any person returned from the tropics who becomes ill, suspect malaria" and "Before a disease can be diagnosed, it must be thought of."

The principal diagnostic features of some tropical diseases include findings of considerable radiological importance. In the treatment of a few of them, the judicious use of irradiation is of value.

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# Osteoporosis Circumscripta Cranii: Its Pathogenesis and Occurrence in Leontiasis Ossea and in Hyperparathyroidism<sup>1</sup>

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THE PATHOGENESIS and classification of the large, irregular, circumscribed areas of osteoporosis of the cranium first described by Schüller<sup>2</sup> were for some time subjects of mere speculation. Schüller (14, 15) himself did not originally point out the intrinsic significance of his striking radiological findings. Soon, however, Sosman (17, 18) provided histologic observations indicating a relationship between osteoporosis circumscripta and Paget's disease. Further clinical and radiological investigation seemed to corroborate this evidence to a great extent, and osteoporosis came to be generally considered as an atypical form or precursor of Paget's disease, "probably the absorptive or destructive phase with the productive phase held in abeyance" (17). Its occurrence solely in the skulls of persons suffering from Paget's disease was thought to be related chiefly to the peculiarities of the diploic circulation, the cranial architecture, and the statics of the bones of the cranium (6).

Subsequent histologic studies, however, did not unanimously support the view that circumscribed osteoporosis is without exception an early or atypical form of Paget's disease of the skull. While a group of observers (2, 16, 20) microscopically verified the identity of the two conditions in four cases, Schmorl's (13) interpretations were different. In the skulls of five persons who had been suffering from Paget's disease he saw gross as well as microscopic departures, which he identified as the results of circulatory disturbances. They seemed to resemble hemorrhagic infarc-

tions rather than the anatomical changes characteristic of Paget's disease. In gross appearance they corresponded to the fundamentals of osteoporosis circumscripta. A similar observation was made by the present writer (20). In a verified case (Case II) of osteoporosis he saw discolored areas of deep reddish hue in the cranium, which revealed microscopically an unusual hyperemia, small hemorrhages into the bone marrow, and advanced decalcification of the bone tissue, but no signs of Paget's disease. A third group of pathological findings, reported by Schellenberg (12), and later Guillain, Ledoux-Lebard, and Lereboullet (3), bore more resemblance to osteitis fibrosa than to Paget's disease.

A review of the literature shows that clinically about 60 per cent of the published cases of osteoporosis circumscripta have been associated with Paget's disease; 20 per cent, however, were connected with leontiasis ossea or bony tumors of the maxilla and not with Paget's disease. In the remaining 20 per cent the skull only was examined and not the entire skeleton; consequently, no statement can be made concerning the presence or absence of Paget's disease in these patients.

It seems, therefore, that leontiasis ossea constitutes the second largest group of abnormalities in which osteoporosis circumscripta occurs, and the coincidence of these conditions is so frequent as to have definite significance. Yet this association did not substantially increase our knowledge of osteoporosis, nor did it change our conception of its pathogenesis, despite repeated attempts (1, 6) to emphasize the connection between the two conditions. This failure to influence opinion concerning the causative relation between osteoporosis and Paget's disease may be due to the confusion in the identification of leon-

<sup>1</sup> From the Department of Radiology, Stanford University School of Medicine, San Francisco, Calif. Accepted for publication in April 1944.

<sup>2</sup> Kasabach and Gutman (6) called attention recently to the fact that Sherwood Moore (10) observed osteoporosis circumscripta in a case of Paget's disease in 1923. Moore later confirmed this statement (11).

tiasis ossea itself. In one of the cases reported by Kasabach and Gutman (6), for instance, in which osteoporosis was associated with a condition believed to be leontiasis ossea, the latter was variously interpreted as leontiasis ossea, Paget's disease, osteitis fibrosa, osteofibroma, and osteoma. In fact, it is not until recent years that progress has been made in the differentiation and classification of the various types of this rare disease (7, 19). It is thought today that probably more than a third of the cases described and published as leontiasis ossea were in fact Paget's disease, while another large group was found to be osteitis fibrosa cystica (type von Recklinghausen). The true form, called type Virchow, proved to be the rarest of all conditions published under the denomination of leontiasis ossea. It is not unlikely, therefore, that in some cases in which osteoporosis was associated with a disease considered to be leontiasis ossea we were in reality confronted with Paget's disease. This may be the reason why so little consideration was given to those remarkable observations which might have changed our concept of the pathogenesis of osteoporosis circumscripta.

Recently, the author had the opportunity to observe the occurrence of osteoporosis circumscripta in a case of histologically verified leontiasis ossea (type Virchow).

**CASE I:** A 63-year-old white woman had been suffering since 1921 from repeated dental infections and from sinus trouble. At that time x-ray examination supposedly revealed that parts of the bone of the upper jaw were "filling in." In 1931 the patient noticed that her right cheek bone was becoming more prominent. In 1934 her upper gum began to grow thicker and the left cheek began to protrude. Several sinus operations were performed and a number of teeth were extracted. Each instrumentation seemed to the patient to aggravate the condition and to increase the size of the maxilla. On admission (1944) the cheek bones, especially the area of the zygoma, on both sides, were prominent. The eyes lay deep in the facial bones. The gums were thickened up to 2 cm., covering almost entirely the few remaining teeth. The face was stiff, moving but little when the patient spoke and having a mask-like appearance (Fig. 1). There was no tenderness over any part of



Fig. 1. Case I: Portrait of patient with leontiasis ossea, showing protrusion of maxillary areas on both sides and greatly thickened gums.

the face and the percussion note over the cranial vault was not abnormal. There was present a smooth elevation in the right parietal area, protruding a few millimeters above the level of the bone.

Other findings were of no significance. No impairment of vision or hearing was noted, and no abnormalities of the extremities were observed. No evidence of Paget's disease was discovered in any part of the skeleton.

The Wassermann reaction was negative. The blood count was within normal limits. Blood chemistry (followed up for three months): calcium 13.5-7 mg.; phosphorus 4.0-7.0 mg. per 100 c.c. of serum; phosphatase activity 8-12 Bodansky units.

The x-ray examination revealed an extensive thickening of almost all the bones of the face, resulting in a marked protrusion of the zygomatic regions and of the anterior walls of both maxillary sinuses. The lateral wall of the antrum and the alveolar process on both sides were remarkably thickened, relatively translucent, revealing, however, some denser areas in the vicinity of the remaining teeth. The nasal cavity, too, was narrow, and all the sinuses were obscured. The bones of the base of the skull were not visibly changed. The sphenoid sinus was small and partly filled out by bone (Fig. 2).

The skull was symmetrical: the thickness of the vault measured about 7 mm. The sutures were obliterated. The inner table was smooth. There was a large irregular defect involving the right half of the frontal bone and parts of the parietal and occipital bones on the right. It was irregularly bounded and went through the obliterated sutures

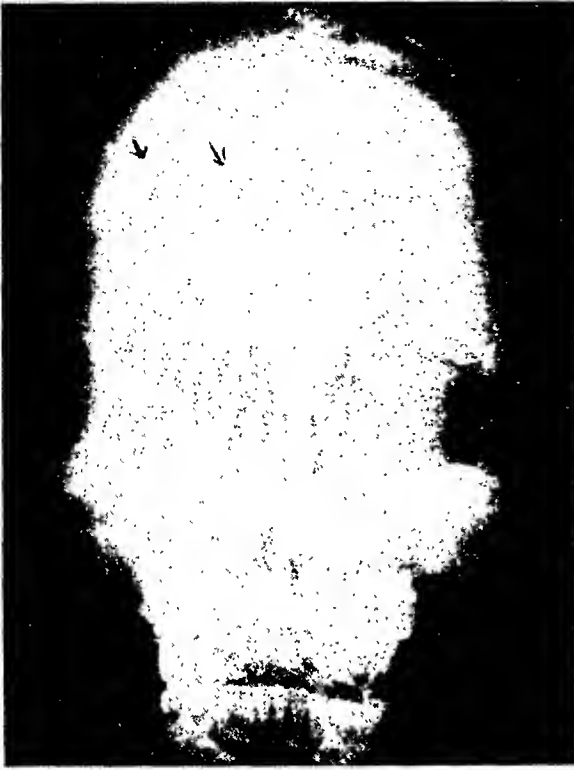


Fig. 2. Case I: Postero-anterior view of the skull, showing considerable thickening and sclerosis of the maxilla and of the malar bones. Partial obliteration of the maxillary sinuses and of the nasal cavity. Osteoporosis circumscripta indicated by arrows.

without changing its outlines. In the area of the defect both the internal and external table had become thinner, and almost the entire thickness of the bone was formed by the diploe. This contained little calcium and consequently a large defect was observed in the roentgenograms of the vault (Fig. 3).

The skeleton was carefully studied fluoroscopically; roentgenograms were made of the spine, pelvis, and lower extremities and no abnormalities were discovered.

On Jan. 6, 1944, a biopsy was done in the area of the alveolar process of the right maxillary second incisor and cuspid. The patient believed that this area was steadily getting thicker. The surgeon noticed that the bone was remarkably soft. The specimen obtained was dark red, and fine bone spicules were palpated in the rough cut surface.

Histologic examination (Figs. 4-5), of which we shall publish a more detailed record later, showed the normal bone structure to be replaced by irregularly distributed bone lamellae embedded in fibrous marrow. The structure of the lamellae consisted of a system of haversian canals with many lamellae parallel to the surface. The bone cells were small but of regular proportion and outline and evenly distributed. No signs of mosaic structure or of dark connecting lines could be discerned. Signs of intense new formation of bone lamellae were present. Fre-

quently the surface of the spicules was surrounded by a layer of osteoblasts and in other parts of the specimen by osteoid layers. Osteoid tissue was also seen in the fibrous marrow. A number of giant cells of osteoclast type were lying in Howship's lacunae. Newly formed bone lamellae were sometimes found in the vicinity of quiescent bone structures without osteoblasts or osteoclasts on their surface. The connective tissue replacing the bone marrow contained some inflammatory cells, some psammoma bodies, and relatively few capillary blood vessels. Additional findings were irregular areas of complete bone resorption (Fig. 6). The latter did not contain bone tissue, marrow, or blood vessels, but were filled out by fine granular eosinophilic material.

The histologic diagnosis was, therefore, as follows: "Complete transformation of the bone tissue with

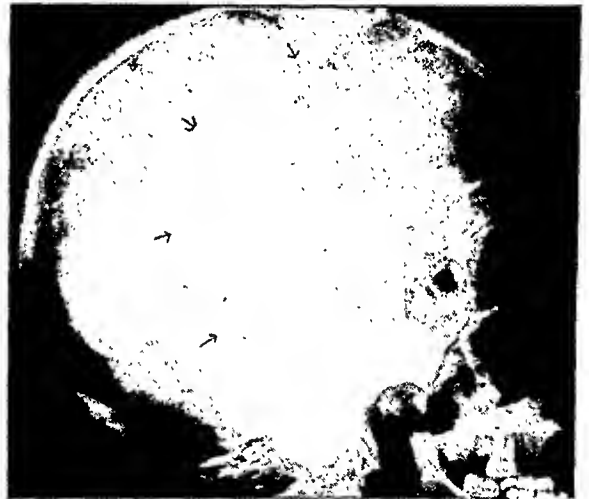
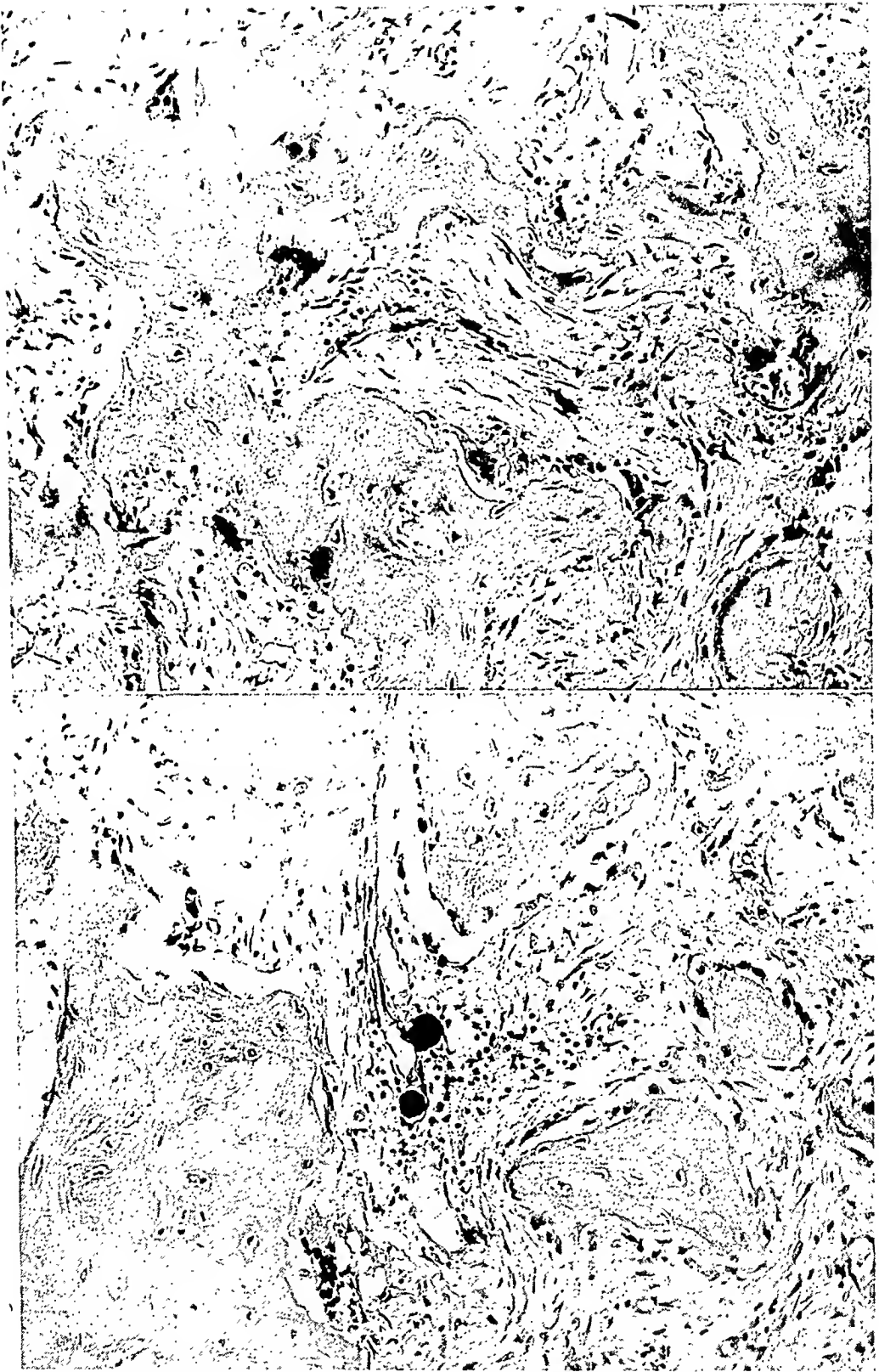


Fig. 3. Case I: Lateral view of the skull. Boundaries of the osteoporosis circumscripta indicated by arrows. Circumscribed density in occiput corresponds to the palpated elevation on the skull.

hyperplasia due to osteoblast activity and simple metaplasia; fibrous bone marrow containing inflammatory cells and capillary blood vessels; bone resorption by osteoclasts with formation of small cavities." There were no changes present suggesting Paget's disease.

*Comment:* The possibility of Paget's disease in this case was excluded by clinical, radiologic, and histologic investigation. Had leontiasis ossea invaded the cranium, as might have occurred, then bony hyperplasias or hyperostoses would have resulted instead of osteoporosis. We have, consequently, to regard the osteoporosis in this particular case as secondary to leontiasis ossea but not intimately and topically connected with it.



Figs. 4 and 5. Case I: Photomicrographs of biopsy specimen from the gum, showing fibrous marrow; new formation of bone lamellae by osteoblast activity; osteoid tissue in the bone marrow; bone resorption by osteoclasts. The lower view shows the inflammatory cell reaction and psammoma bodies in the fibrous marrow.

Pathologically two forms of osteoporosis circumscripta are known. One represents circulatory disturbances, the other Paget's disease. Their radiologic signs are identical, and these same signs occur in the vault in cases of leontiasis ossea. Since no pathological findings other than the aforementioned ones have come to light, and as Paget's disease was excluded in our case, we have to assume that the anatomic basis of the osteoporosis circumscripta in this particular instance was hemorrhagic

porotic lesions are investigated pathologically *before* Paget's disease is established in them, they will reveal, under the microscope, primary changes, such as hemorrhages, hyperemia, and decalcification, despite the fact that the patient has been suffering from Paget's disease. At a later date, Paget's structures might be found. Radiological studies follow similar lines. Osteoporosis occurring in diseases other than Paget's disease will not reveal Paget's structure but will most likely remain in

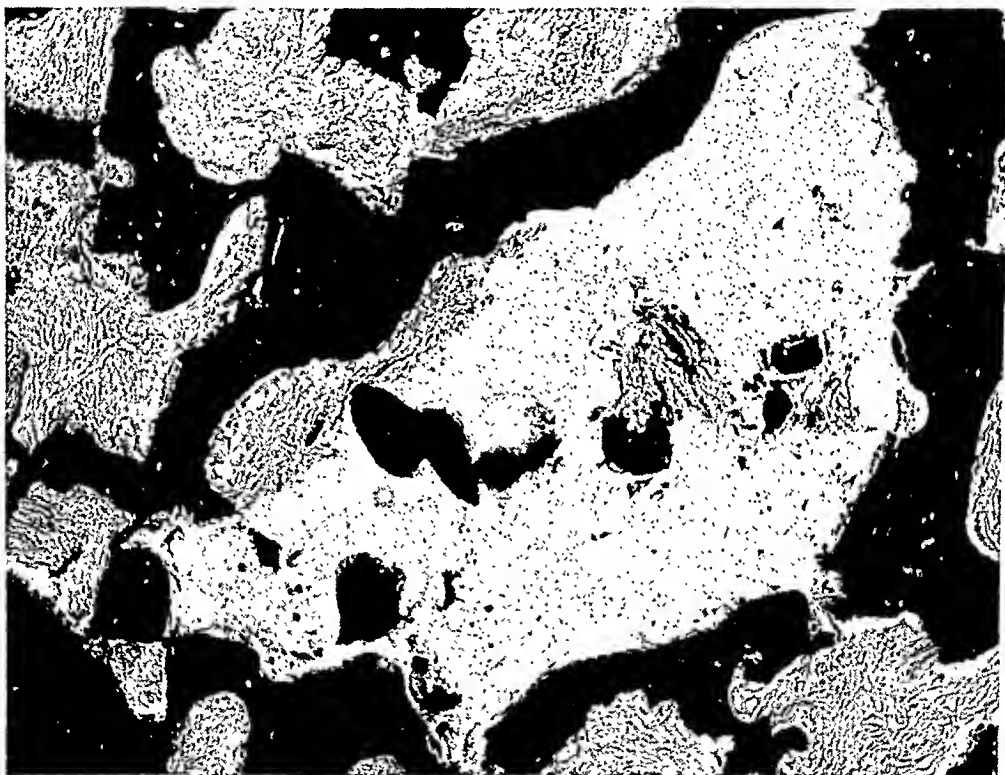


Fig. 6. Case I: Cavity of resorption with liquefaction of small areas of the bone marrow.

changes based on circulatory disturbances and decalcification of the bone tissue. We might as well assume that this form of osteoporosis is a primitive non-differentiated common reaction of the cranium which in cases of Paget's disease may be secondarily transformed into mosaic structures and fibrous bone marrow. This might happen as soon as the disturbed statics of the cranium require a bony reinforcement of the areas of the osteoporosis (sometimes even after as long a period as ten years). Consequently, if the osteo-

a primitive stage, unless the leontiasis ossea or other primary bone lesion associated with its occurrence encroaches upon the osteoporotic areas. Case II is an example.

CASE II: Radiographs (Figs. 7 and 8) of a 58-year-old woman afflicted since her youth with a peculiar bone condition of the skull, called fibrous osteodystrophy, and clinically appearing as leontiasis ossea, showed extensive hyperostoses of the cranium. They were surrounded by wide areas of osteoporosis, giving the impression that the osteoporosis was not a part of the osteodystrophy but a change pri-

marily involving the vault. Hyperostoses seemed to be established in them as secondary transformations.

Another case of osteoporosis circumscripta associated with bone changes of hyperplastic type, namely with hyperparathyroidism, came to our attention a short time ago. It has occasionally been thought that some connection may exist between circumscribed cranial osteoporosis and hyperparathyroidism, though they were never found to occur together. This may be due in part to the fact that skulls

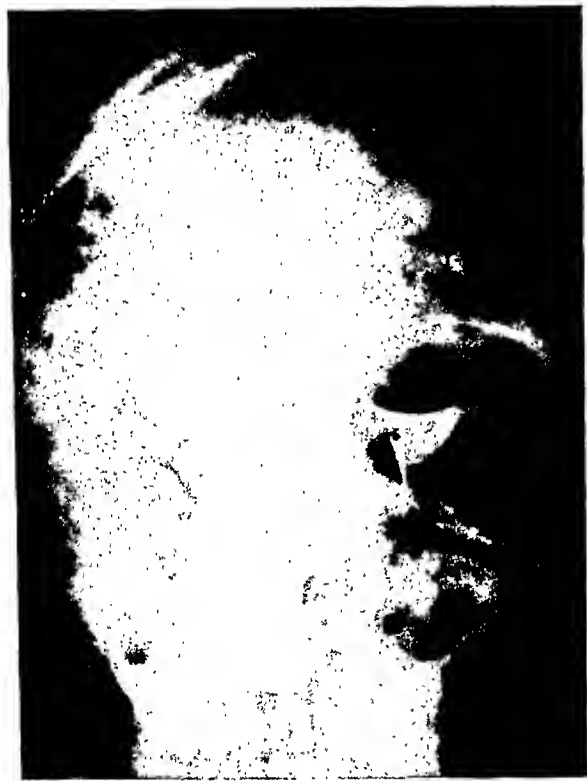


Fig. 7. Case II: Leontiasis ossea caused by osteodystrophy. Marked deformity of the face and displacement of the right orbit by hyperostoses. Obliteration of ethmoid and nasal cavities and of the right maxilla.

in hyperparathyroidism are as a whole diffusely decalcified, and an additional loss of calcium in circumscribed areas is less obvious roentgenographically than in a normal skull. The only cases in which osteoporosis was thought to be histologically related to hyperparathyroidism were those mentioned above as resembling osteitis fibrosa (3, 12). These patients were not afflicted with hyperparathyroidism,



Fig. 8. Case II: Large areas of osteoporosis surrounding hyperostoses of the calvarium. Boundaries of osteoporosis marked by arrows.

and it might be well, indeed, to assume that the interpretation of the histological findings as osteitis fibrosa represents a somewhat generous use of this terminology. Kasabach and Gutman (6) found in one of their cases (No. 20) osteoporosis circumscripta of the frontal and occipital bones and Paget's disease of the tibia. Examination of the blood unexpectedly yielded values more consistent with hyperparathyroidism. A parathyroid tumor was subsequently removed. Sosman (18) made the observation that x-ray irradiation of the area of the parathyroid glands produced a reossification of osteoporotic lesions. The mechanism of the action of x-rays, however, is not quite clear for, in addition to the parathyroid glands, other structures have been irradiated at the same time.

CASE III: A third case studied by the author was that of a 56-year-old woman, who had suffered more than five years from a painful bone condition. At the same time she had a chronic kidney infection with stones. One stone had been removed in 1927. The pains in the bones and joints had increased so appreciably in the last two years that the patient became bedridden. Her ribs and pelvis were extremely tender to the touch. She was moderately anemic and all the time had an increased non-protein nitrogen in the blood.

The first roentgenograms of the skeleton were not entirely characteristic of hyperparathyroidism. They were variously interpreted as metastatic carcinoma, menopausal disturbances, and bone changes due to chronic renal deficiency. After several years





Fig. 9. Case III: Circumscribed osteoporosis in hyperparathyroid skull. Boundaries of osteoporosis marked by arrows.

of observation, however, more or less typical clinical, radiological, and biochemical evidence of hyperparathyroidism became apparent, and after a fracture of the right femur, a parathyroid adenoma was removed (Dr. Eloesser). It measured  $3.5 \times 2.5 \times 2.8$  cm. and weighed 7 gm. Histologic examination showed it to be of mixed chief and water-clear cell type. The patient's blood calcium never exceeded 12.7 mg. per 100 c.c. of serum. The phosphorus averaged between 4.6 and 5.3 mg., and the phosphatase activity was 39.3 Bodansky units. Three weeks after the removal of the tumor the phosphatase activity decreased to 12 Bodansky units. At the same time the blood calcium had a level of 6 mg. and the phosphorus 2.5 mg. per 100 c.c. of serum. Soon after operation tetany developed but was controlled by calcium medication, and the clinical condition improved temporarily.

X-ray examination of the skeleton showed the extensive changes common in advanced hyperparathyroidism. There was an extraordinary disturbance in many of the bones, consisting in diffuse osteoporosis except in the vertebral bodies, which were of increased density. Multiple cysts were seen in the innominate bones and in the upper end of each femur and in two ribs. The long bones were slightly deformed, and the trabeculation of the spongiosa was irregular. The skull was symmetrical, the calvarium up to 16 mm. thick, with granular decalcification and hyperplasia of the diploic layers. The inner and outer tables were almost indistinguishable, and a fine granular mottled diploe gave an appearance characteristic in hyperparathyroidism. There was a large circumscribed area of increased translucency involving the right frontal, parietal, and temporal bones (Fig. 9). Sharp outlines toward the posterior portions of the vault gave a distinct contrast between the structureless and consequently almost calciumless anterior areas of osteoporosis and

the fine granular mottled posterior portions of the cranium. There was a wide oblique spontaneous fracture line through the occipital squama, such as occurs occasionally in cases of excessive decalcification in hyperparathyroidism.

*Comment:* The localization, outlines, and distribution of the osteoporotic areas in the cranium in this case of hyperparathyroidism were similar to those seen in Paget's disease and in leontiasis ossea. The osteoporosis developed about five years after the first signs of bone changes in the cranium were noticed. This corroborates our previously expressed opinion and might permit us to assume that the structural changes caused by hyperparathyroidism had possibly acted on the circulatory system of the skull in a similar way to that of hyperplasias in Paget's disease or in leontiasis ossea. Signs of rapid decalcification of the skull had been observed from the beginning. Only later, however, as the bone changes were more advanced (so as to impair the blood circulation of the calvarium), were additional areas of more profound decalcification, namely osteoporosis circumscripta, detected.

Despite the conclusive clinical, radiological and biochemical findings and the presence of the parathyroid adenoma, the early course of this case was not entirely typical of hyperparathyroidism. The vertebral bodies were remarkably dense, and the reaction of the patient to the parathyroidectomy was slight. We had to assume that a spontaneous reossification of parts of the skeleton had begun before the removal of the parathyroid tumor, as in the cases of Lindén (8), Jacobs and Bisgard (4), and others. Some balance, therefore, between the parathyroid activity and the calcium metabolism was at that time already established. This would explain, too, the development of tetany after the removal of the parathyroid tumor.

The significance of our findings of circumscribed osteoporosis in this hyperparathyroid skull remains, in spite of the above diagnostic complications, inasmuch as the radiological appearance of the skull

in hyperparathyroidism is not specifically characteristic of that disease. It occurs as a reaction of bone tissue to rapid decalcification regardless of the cause.

#### CONCLUSION

The coincidence of osteoporosis circumscripta (Schüller) with a proved case of leontiasis ossea (type Virchow) and its occurrence in hyperparathyroidism furnish conclusive evidence that this condition

are not distinguishable from the non-differentiated form. (Later, cotton-wool structures appear in cases of Paget's disease.) It is not unlikely that occasionally encroachment into the cranial vault by leontiasis ossea is preceded by osteoporosis circumscripta (see Case II). Clinically, approximately 60 per cent of the known cases of osteoporosis circumscripta are connected with Paget's disease. Other associated conditions were leontiasis ossea,



Fig. 10. Longitudinal section of an obliterated blood vessel bordering margins of quiescent and growing bone tissue (Case 1).

cannot be considered as a precursor or an atypical form of Paget's disease, as has been thought. It is to be regarded as a bone reaction characteristic of the structural architecture of the cranium but not indicative of a specific disease. Distinction can be made histologically between a primitive, non-differentiated form (decalcification with hyperemia and other signs of circulatory disturbances) and a secondary, differentiated form (in which proved cases were limited to Paget's disease). Radiologically, early stages of differen-

bony tumors of the jaw, hyperparathyroidism, and brain tumors.

Concerning the pathogenesis, all findings converge on circulatory disturbances caused by space-occupying lesions near the base of the skull or in the facial bones. Statistically the bony hyperplasias of Paget's disease are most frequent. Microscopic serial examination of our biopsy specimens occasionally revealed obliterated blood vessels running into areas of quiescent bone tissue with no cellular reaction around the lamellae. The vessels



were surrounded by growing bone tissue and fibrous marrow (Fig. 10). Areas of primitive osteoporosis may undergo structural transformation corresponding to the demands or pretensions of the statics of the vault. In cases of Paget's disease mosaic structures, new formation of bone tissue, and fibrous metaplasia of the bone marrow may occur microscopically in areas of osteoporosis, furnishing the anatomical basis of the cotton-wool structures of the roentgenograms

#### SUMMARY

1. Osteoporosis circumscripta (Schüller) has been described in the skull of a 63-year-old woman suffering from leontiasis ossea. Histologic examination of a biopsy specimen in this case permitted us to classify the lesion as leontiasis ossea (type Virchow) and to exclude Paget's disease.

2. Osteoporosis circumscripta was observed in the skull of a 56-year-old woman with hyperparathyroidism.

3. Osteoporosis circumscripta cannot be regarded as a type of or a phase of Paget's disease or of any disease entity. It occurs most often in Paget's disease, however, and frequently may be transformed into it. The "primitive" form of osteoporosis circumscripta, described in this paper, is a characteristic reaction of the bones of the cranium and is most likely caused by circulatory disturbances in the presence of bony hyperplasias or of bony tumors near the base of the skull.

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# Significant Skeletal Irregularities of the Hands<sup>1</sup>

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CAREFULLY conducted roentgenographic examination of the hands frequently may be as valuable a procedure to the roentgenologist as funduscope observation is to the ophthalmologist. It is well known that the ophthalmoscope often reveals changes in the eyegrounds which denote the presence of either generalized systemic disease or a localized pathological process in some remote portion of the body. The fact that similar diagnostic potentialities are inherent in the skeletal structure of the hands and wrists has not been so fully appreciated.

Diagnostic prospecting in the form of roentgenographic skeletal survey in search of an obscure disease process is a commonly employed procedure, especially in pediatric practice. In many instances "films of the long bones" furnish the key to what has previously been a diagnostic puzzle. Unfortunately, roentgenograms of the hands are often deemed unimportant in such a survey, although, in reality, no part of the skeleton may be more revealing.

Examination of the hand is probably the simplest of all radiographic procedures, but this very simplicity tends to produce laxity on the part of the examiner, inattention to details of examination, and slipshod technical results. The sight of one or several phalanges obscured by identification markings, clipped film corners, etc., is too often the rule rather than the exception. These technical blemishes are unsightly and unnecessary. On occasion, their presence may lead to serious diagnostic errors of omission, particularly in infants and young children, in whom the metacarpals and phalanges are relatively small and notoriously difficult to position.

Todd's splendid monograph (1) on the maturation of the hand emphasizes in effect the desirability of good film quality and it would be of distinct value if it went no further. Greater importance lies in the fact that this monograph constitutes an excellent normal standard with which to compare the abnormal. Against this background of near perfection in normalcy, it seems justifiable to review some of the significant skeletal abnormalities of the hand, laying particular stress upon those carpal, metacarpal, and phalangeal changes which reflect the presence of disease elsewhere in the body.

## ENDOCRINE DISEASES

Some of the unusual manifestations of the endocrinopathies are reflected in the hands and wrists in such a manner as to make the etiologic factor recognizable from a study of these structures alone. This is true not only of infants and children but of adults as well. For example, the roentgenographic appearance of the hands in acromegaly is so characteristic that the presence of a pituitary eosinophilic adenoma may be suspected even in the absence of intrasellar erosion. Large, broad, spade-like hands with overgrowth of the terminal phalangeal tufts, prominence of bony protuberances along the shafts of metacarpals and phalanges, and a peculiar soap-bubble pattern of distorted trabeculae in the bone ends comprise the changes commonly encountered.

Many disease entities in infancy and childhood produce delay in the time schedule of epiphyseal ossification, but none is so profound as that seen in cretinism. In addition to retarded bone age, the untreated cretin may have bands of increased density in the ends of the tubular bones such as one might expect to see in lead poisoning or osteopetrosis. All of these

<sup>1</sup> From the Department of Roentgenology, University of Michigan, Ann Arbor, Mich. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

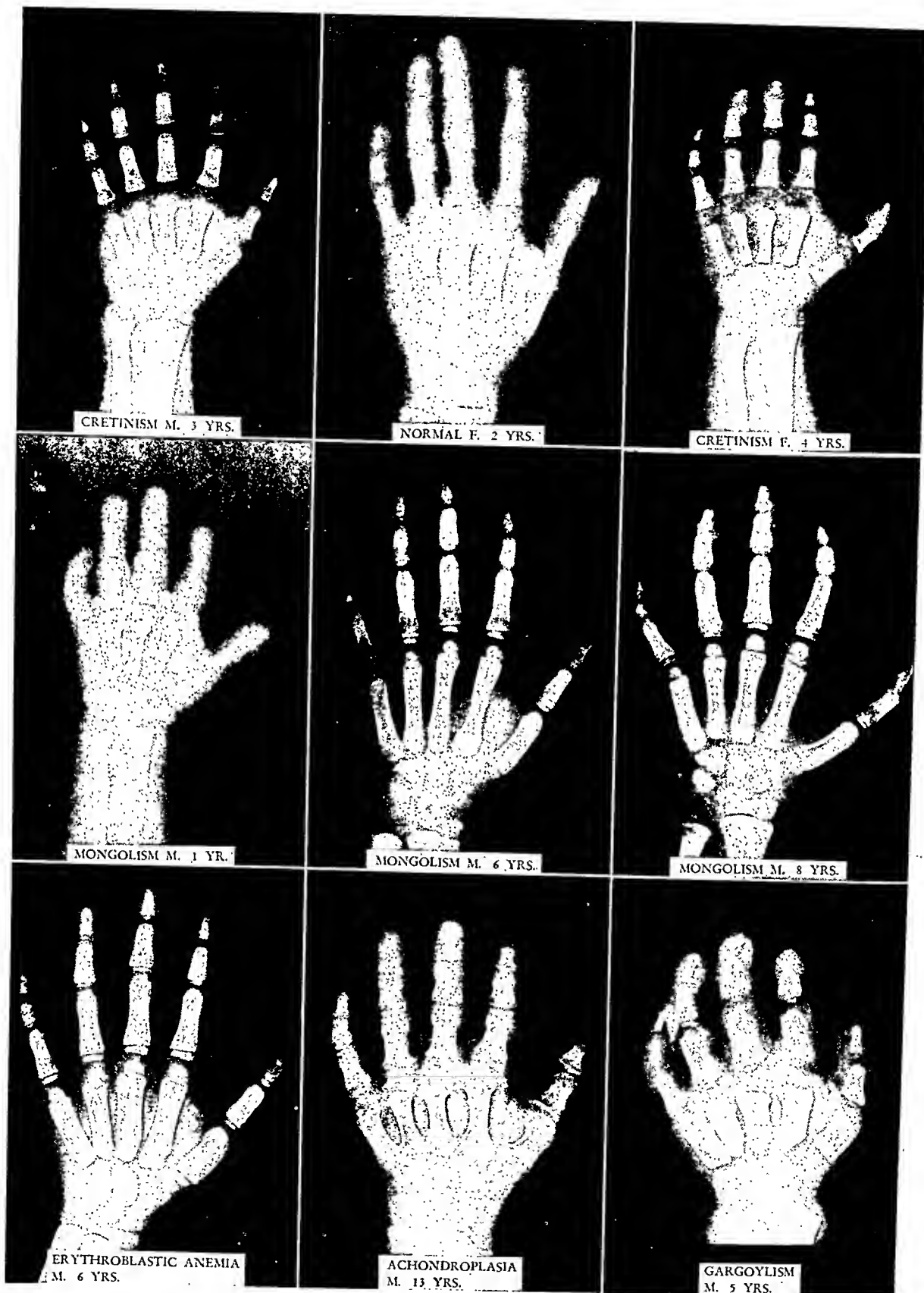


Figure 1.

changes, as well as their dramatic response to thyroid medication, are best studied in the bones of the hands and wrists.

The differential diagnosis between cretinism and mongolian idiocy may be facilitated by accurate interpretation of hand roentgenograms. In contrast to delayed ossification in the cretin is the relatively normal bone development seen in mongolism. Furthermore, the mongol may present fairly typical anomalies of the hands, chief among which is congenital shortening of the middle phalanx of a stubby, curved fifth finger. This abnormality, which represents valuable confirmatory evidence when present, was first described by Smith (2) in 1896, but references to it in roentgen periodicals are not numerous. Recent reviews of the subject by Hefke (3) and ourselves (4) have convinced us of the worth of this sign in the diagnosis of mongolism.

The "fibrocystic" bone lesions of hyperparathyroidism and polyostotic fibrous dysplasia, the peripheral degenerative changes of progeria, and the congenital anomalies, plus alterations in normal epiphyseal closure, associated with other endocrine dysfunctions constitute just a portion of the host of abnormalities in this category that are well shown in the bones of the hands. Hurxthal and Hare (5) have described changes in the metacarpals and phalanges which they maintain are practically pathognomonic of primary prepuberal hypogonadism.

#### CONGENITAL ANOMALIES

In addition to the anomalies of the hands which occur in conjunction with various endocrinopathies, certain other abnormalities in this category are worthy of note.

Dysostosis cleidocranialis is still regarded by some as a condition in which defective ossification takes place only in bones laid down in membrane. It is true that there is delayed ossification in the skull, manifested by multiple wormian bones, large fontanelles, and widely separated sutures. The clavicles are abnormal, varying from under-development to complete absence. But, as Brailsford (6) has emphasized,

other bones are involved, and chief among these, as far as characteristic alterations in normal structure are concerned, are the hands. The ungual phalanges are short and conc-shaped, with failure of the usual prominent cancellous tufts to develop—the same tufts that are so exaggerated in acromegaly. The metacarpals, as well as the proximal and middle phalanges, have supernumerary epiphyses which fuse much earlier in life than the normal ones. All epiphyses appear broader than normal, so much so in the case of the terminal phalanx of the thumb that one gains the impression that this bone develops from two nuclei. The appearance of the hands in this unusual anomalous condition is quite striking and truly characteristic. It deserves more attention than it has been accorded in the past.

In the hands of the typical achondroplastic dwarf, the second to fifth metacarpals are short, stubby, and of nearly equal length. They are more parallel with one another than normal and, as in the case of the long bones, their ends may be quite bulbous. The phalanges likewise are extremely short and relatively broad.

The atypical forms of chondrodystrophic dwarfism show more characteristic changes, which may be of considerable significance. In Morquio's disease, for instance, the ends of the metacarpals and phalanges are grossly irregular, and the carpal bones, besides reflecting delayed skeletal development, have a striking crenated appearance. In Hurler's syndrome (gargoylism), the metacarpals in particular are unusually short and broad, the middle phalanges have an arrowhead configuration, and the trabecular pattern is very coarse and prominent.

Arachnodactyly is an interesting familial malady, apparently congenital in origin, which derives its name from the long, slender, spider-like fingers which characterize this entity. The roentgen appearance of the hands is unmistakable and when it is identified as such, attention immediately should be focused upon the patient's eyes and heart. Congenital dislocation of the lenses is almost invariably present, and as-

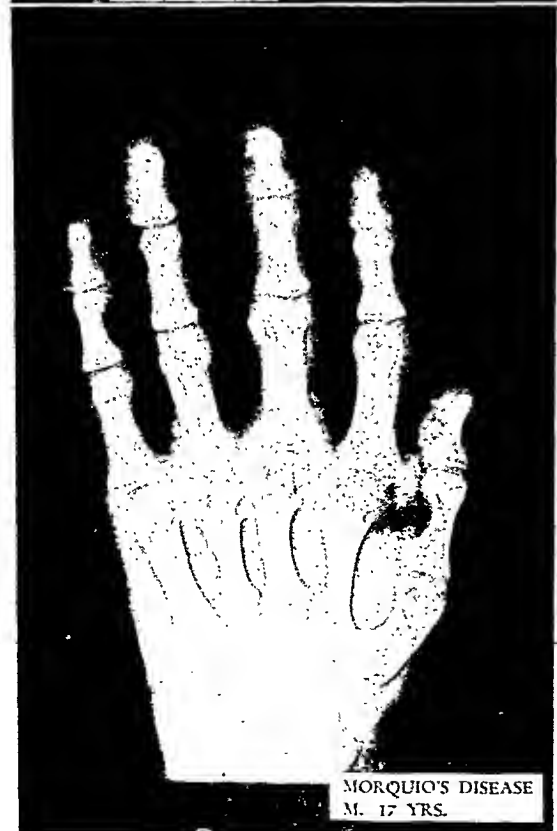


Figure 2.  
26



RAYNAUD'S DISEASE



BUERGER'S DISEASE



SCLERODERMA



CALCINOSIS

Figure 3  
27

sociated congenital heart disease is very common. The great length of the metacarpals and phalanges may be still further accentuated by the presence of supernumerary epiphyses.

#### TROPHIC DISTURBANCES

Roentgenograms of the hands may reflect the presence of syringomyelia, leprosy, Raynaud's disease, erythromelalgia, thrombo-angiitis obliterans, arteriosclerosis, and diabetes, although it must be pointed out that the roentgen signs seen in these various diseases are quite similar and, therefore, of little differential diagnostic value. The outstanding feature common to all of the above conditions is slow, spontaneous amputation of portions of the phalanges or perhaps the entirety of one or more of these bones. Certain more selective diagnostic features have been described (7, 8, 9).

Scleroderma and acrosclerosis may also produce gradual, progressive absorption of the distal phalanges of the hands. In addition, there may be extensive osteoporosis of the juxta-articular portions of the metacarpals and phalanges, soft-tissue contracture deformities and, occasionally, soft-tissue deposition of calcium salts. The combination of these manifestations produces a fairly typical roentgen picture, which should not go unrecognized. The relationship of scleroderma and generalized calcinosis is of special interest, and the discovery of calcium in soft tissues of the hands should focus attention upon other regions of the body, especially when associated osseous changes are present.

#### CHRONIC GRANULOMAS

The bones of the hands may be involved by any form of non-specific inflammatory disease or the various specific granulomatous processes. Tuberculous dactylitis, commonly called spina ventosa because an involved metacarpal or phalanx appears to be distended by air, produces the most characteristic appearance. Identification of this lesion may lead to the discovery of tuberculosis elsewhere in the body.

In 1920 Jüngling (10) described an entity consisting of multiple cyst-like areas of destruction in the bones of the hands and feet with adjacent soft-tissue swelling and associated lesions of the skin and lymph nodes. He felt that this was another manifestation of tuberculosis and gave it the name of osteitis tuberculosa multiplex cystica. We now know that these bone changes and the bone lesions occasionally associated with Boeck's sarcoid are one and the same. The correlation of sarcoid lesions involving the bones, skin, lymph nodes, and lungs has been clearly demonstrated, but the etiological relationship to the tubercle bacillus is as obscure as ever.

Attention is called to the fact that the bone lesions in Boeck's sarcoid are not always punched-out and cystic in character. As Doub and Menagh (11) have pointed out, these lesions may begin merely as a coarsening of the trabecular pattern, following which areas of both cortical and central destruction appear. As the disease progresses, the destruction may assume extensive proportions.

Granulomatous lesions produced by pathogenic fungi may also involve the metacarpals and phalanges and, as in sarcoid, the findings of such lesions should prompt investigation of other regions of the body for additional manifestations of these diseases.

#### PULMONARY OSTEOARTHROPATHY

The existence of long standing chronic pulmonary or mediastinal disease may be suspected from a mere clinical inspection of the hands when clubbing of the terminal phalanges is observed. Roentgenograms may reveal the additional element of periosteal proliferation along the shafts of the metacarpals and phalanges—so-called hypertrophic pulmonary osteoarthropathy. The cause of this remote expression of pulmonary disease has not been satisfactorily explained, but its importance as a diagnostic sign cannot be minimized.

Pulmonary osteoarthropathy occurs with greater frequency in non-tuberculous lesions of the chest; in fact, we have been un-



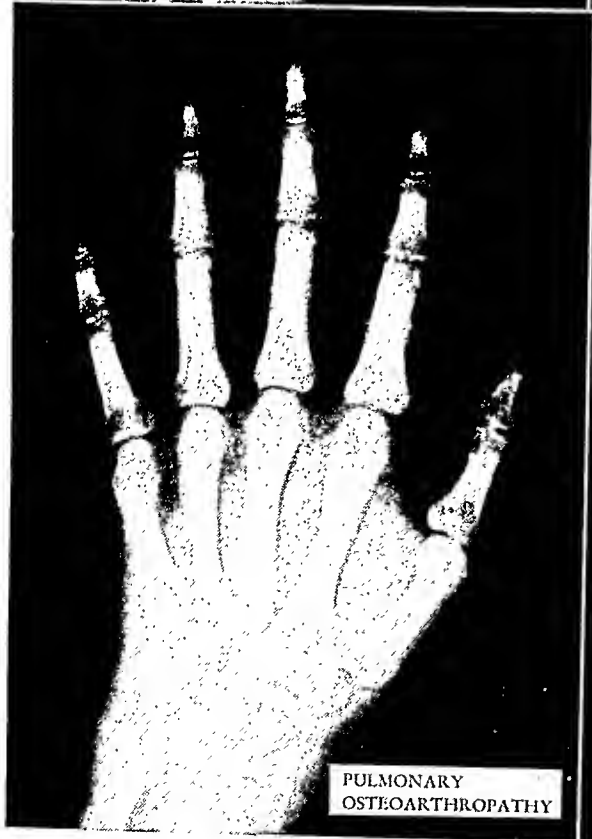


Figure 4.  
29



able to find a single instance of its occurrence in uncomplicated pulmonary tuberculosis in the case records of University Hospital.

Probably the most remarkable feature about pulmonary osteoarthropathy is the fact that its severity, regression, and progress vary directly with the degree of pulmonary involvement. Roentgenograms of the hands may thus serve as fairly accurate indicators of the success or failure of any therapeutic procedure directed toward the causative pathological process within the thorax. Patients in whom the pulmonary lesion is entirely eradicated will show complete disappearance of the bone changes. When, as is much more often the case, the pulmonary lesion becomes progressively worse, the periosteal proliferation becomes accentuated and quite dense. In severe cases this dense new bone formation is difficult to distinguish from the underlying cortical bone. To avoid diagnostic and, more particularly, prognostic error, the roentgenologist must be extremely careful to make this distinction.

#### HEMOPOIETIC AND BLOOD DISEASES

Among the diseases of the blood and blood-forming tissues, hemophilia, leukemia, and the chronic hemolytic anemias may produce valuable roentgenographic signs in the osseous system. The moth-eaten destructive lesions of leukemia occasionally are found in the bones of the hands but are much more clearly recognized in the long bones. Hemophilia expresses itself in the form of articular irregularities in the larger joints. On the other hand, erythroblastic anemia tends to involve the entire skeletal system in such a manner that its roentgenographic picture is unmistakable. In no portion of the skeleton is this picture more clearly demonstrated than in the hand. The metacarpals and phalanges take on a characteristic rectangular shape, the medullary canals are dilated, and the cortices are thinned. The shafts of the bones are traversed by a coarse, irregular meshwork of dense, broadened trabeculae which stands out in bold

relief against an over-all background of atrophic bone substance. Whereas this pattern is seen in the ends of the long bones, it is very prominent throughout the entire length of the metacarpals and phalanges and thus produces a striking effect that can be recognized at an earlier stage in the disease process. Moreover, the delayed ossification that invariably accompanies the malady can best be appreciated in the carpal bones.

Only isolated instances of similar bone changes have been reported in sickle-cell anemia and chronic hemolytic jaundice. We have not encountered them in such cases as have come to our attention.

#### MISCELLANEOUS LESIONS

The value of roentgenography of the hands in the diagnosis and prognosis of the various types of chronic non-specific arthritis cannot be overestimated. Roentgen signs of rheumatoid arthritis, consisting of osteoporosis, reduction of cartilage spaces, and areas of subchondral bone destruction, usually make themselves apparent in the proximal interphalangeal joints before they appear in other joints. When these changes are seen in and adjacent to the distal interphalangeal joints alone, the possibility of so-called arthropathia psoriatika may be reasonably considered. This implication is justifiable because uncomplicated rheumatoid arthritis seldom, if ever, involves the distal interphalangeal joints to the exclusion of all others. Osteo-arthritis usually manifests itself first in the distal interphalangeal joints, and the ridges of osteophytes that appear give rise to the classical, clinically recognizable swellings known as Heberden's nodes.

Gout reflects a disturbance in purine metabolism and, although tangible roentgenographic evidence of this disease is commonly associated with the feet, the bones of the hands may show intramedullary and extramedullary destructive changes due to adjacent tophi which may be just as extensive as those in the lower extremities.

Chondromata and solitary cysts are not

uncommonly encountered in the bones of the hand. Curiously enough, the occurrence of chondromata in the hands is occasionally associated with the presence of similar lesions in other bones. Other neoplastic lesions appear so rarely in the hand bones that they will not be considered.

Osteopoikilosis, osteopetrosis, and melorheostosis are some of the additional abnormalities that are occasionally encountered in the hands and wrists. The roentgen appearance of each of these entities is characteristic enough to permit accurate diagnosis from hand roentgenograms alone. Tuberos sclerosis sometimes produces rarefactions in the phalanges.

#### SUMMARY

An attempt has been made to focus well deserved attention upon roentgenograms of the hand as a source of important diagnostic information. In addition to purely local pathological processes, the alterations of normal carpal, metacarpal, and phalangeal structure which reflect the presence of remote systemic disease entities are worthy of careful consideration. A single dorsal-palmar projection of the hand is generally more valuable in this respect than other portions of the skeleton because of the technical simplicity of the procedure, the absence of confusing overlapping shadows, and the relative rapidity of change in the hand and wrist bones during the period of maturation.

Although many of the abnormalities

discussed are rarely encountered, the hand changes in certain instances are virtually diagnostic, and familiarity with them will bring about prompt evaluation and accurate classification of the disease process responsible for their production.

Dr. M. Cooperstock, Marquette, Mich., and Capt. A. H. Joistad, M.C., A.U.S., supplied the illustrative roentgenograms of arachnodactyly and osteopoikilosis respectively.

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# Tuberculosis of the Greater Trochanter and Its Bursa<sup>1</sup>

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**T**UBERCULOSIS of the greater trochanteric bursa is a rare condition and is usually secondary to tuberculous osteomyelitis of the greater trochanter. A perusal of the literature substantiates these observations.

The early writings on trochanteric bursitis are, for the most part, case reports of inflammatory lesions, without mention of the etiologic agent. It was not until 1904 that the concomitant involvement of the greater trochanter was recognized by Wieting (1), who believed, as did several later writers, that the primary infection is in the trochanter, whence it spreads to the bursa. Clopton (2), Keith (3), and others supported this view and pointed out that, since the greater trochanter develops as an epiphysis, it is as such susceptible to tuberculous infection, which would further establish the probability of primary involvement of the bone and secondary invasion of the bursa. Cone (4) in 1911 and Swindt (5) in 1921 stressed the significance of trauma as an etiologic factor and noted the rarity of tuberculosis of the greater trochanter in children. In 1933 Meyerding and Mroz (6) reported a series of 19 cases of tuberculosis of the greater trochanter and its bursa. Fourteen of these were on the right side, which, they believe, favors trauma as playing an etiologic role. In 73 per cent of the series evidence of tuberculosis was found elsewhere in the body. Donovan and Sosman (7) in 1942 reported 5 cases, in all of which there was evidence of tuberculosis elsewhere, healed, active, or inactive. This is true, also, of the cases to be recorded here. Two of the cases reported by Meyerding and Mroz and one of Sosman and Donovan involved only the bursa. All writers agree that complete extirpation of all infected tissue,

with immobilization of the affected part, followed by body-building postoperative care, is the treatment of choice.

## CLINICAL FINDINGS

Tuberculosis of the greater trochanter and the greater trochanteric bursa may occur at any age and in either sex but, as previously noted, is unusual in children. Occupation has no bearing on the incidence. The usual complaint is mild pain in the involved leg over a long period of time, with intervals of quiescence. Often there is a draining sinus over the trochanteric area. Some patients give a history of trauma before the onset of symptoms, but frequently this is difficult to evaluate.

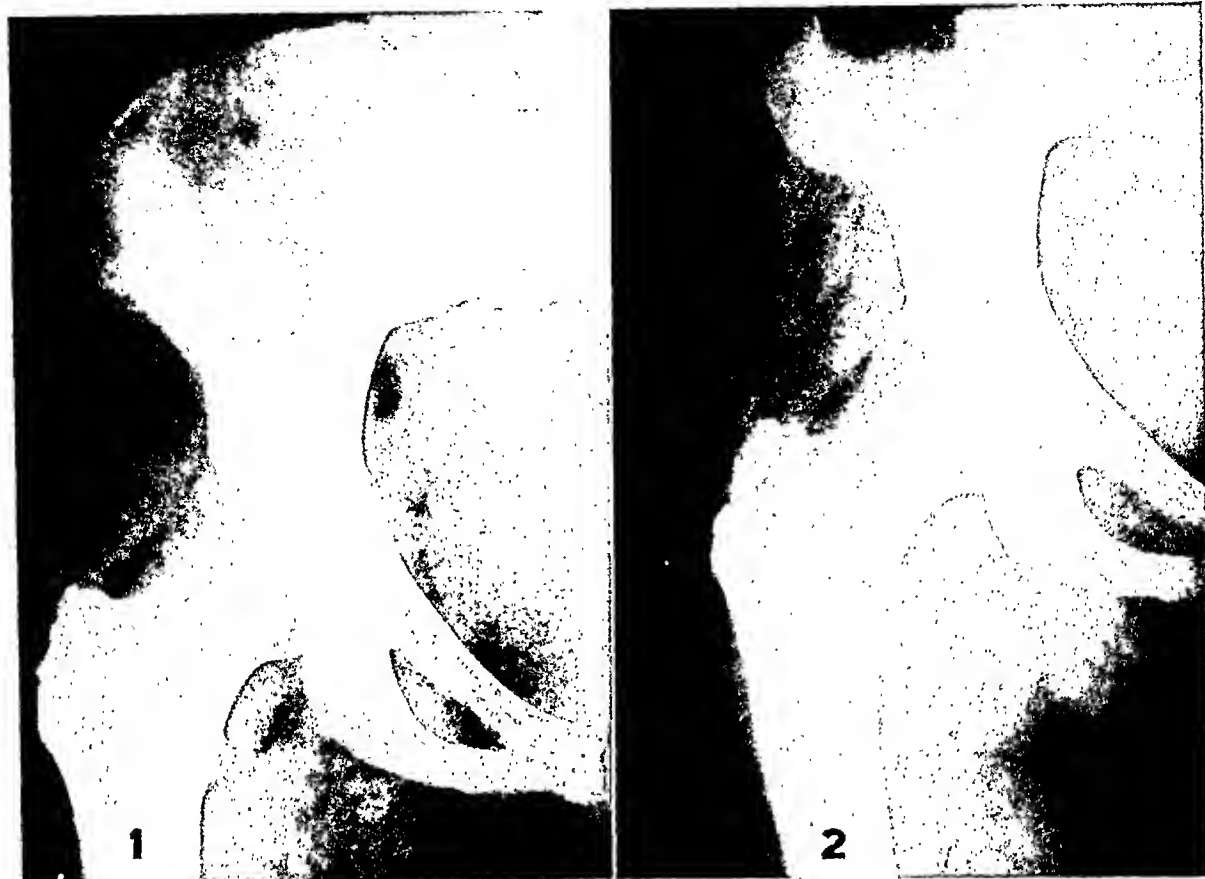
Examination shows slight swelling over the trochanteric area, with tenderness to pressure, but no heat or redness. Weight-bearing is usually painless, and motion of the hip is free. Evidence of tuberculosis, active or inactive, can be demonstrated elsewhere in the body in most of the cases.

There is a strong tendency for the condition to recur and, if a series of cases is followed over a period of years, a high percentage of recurrences will be found. Some of these will show extension of the process, with involvement of the neck and head of the femur. The joint itself may finally be involved. Where the disease is limited to the bursa, the percentage of cures is believed to be somewhat higher.

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The first roentgen evidence of tuberculosis of the greater trochanter may be a small fleck of calcium in the bursa or a minimal area of destruction in the outermost part of the trochanter. These are often difficult to demonstrate with the usual bone technic, and may easily be missed. Donovan and Sosman (7) recommend a light technic comparable to the soft-tissue technic used to demonstrate calcification

<sup>1</sup> From the Department of Roentgenology, Henry Ford Hospital, Detroit, Mich. Accepted for publication in March 1944.



Figs. 1 and 2. Case 1: Destruction of the greater trochanter of the right femur with calcification of the bursa. Figure 2, ten months after operation, shows evidence of repair in the previously involved area. No evidence of activity is present.

around the shoulder. In this manner small calcium deposits in the bursa and early erosion of the cortex can be demonstrated.

The usual appearance on the roentgenogram is an area of destruction in the greater trochanter with osteoporosis of the adjacent bone. There is usually some soft-tissue swelling of the area, with calcium deposits in the bursa. Sometimes an involucrum is formed in the soft tissues lateral to the trochanter. This, however, is found in long-standing cases in which an operation has been done, or in those cases in which there has been a draining sinus for a long period of time, and is probably the result of secondary infection or injury to the periosteum.

#### DIFFERENTIAL DIAGNOSIS

Simple inflammatory (non-specific) bursitis of the trochanteric bursa can and does occur and must be differentiated from tu-

berculous involvement. The symptoms are more acute and are usually promptly relieved by simple treatment. The presence of acute symptoms, absence of a sinus tract, and/or absence of involvement of the trochanter, along with prompt response to simple remedial measures, aid in the differential diagnosis.

Differentiation from tumors involving the trochanter does not usually offer much difficulty. In one of our cases (Case 1), however, a diagnosis of neoplasm of the femur was made at another hospital and the patient was given deep therapy. Later a biopsy proved the condition to be inflammatory.

Non-specific osteomyelitis involving the greater trochanter offers a problem in differential diagnosis, and in certain stages the roentgen picture is identical with that seen in tuberculosis. In such cases the clinical course and past history are helpful.

# Tuberculosis of the Greater Trochanter and Its Bursa<sup>1</sup>

PAUL C. BRIEDE, M.D.

Lansing, Mich.

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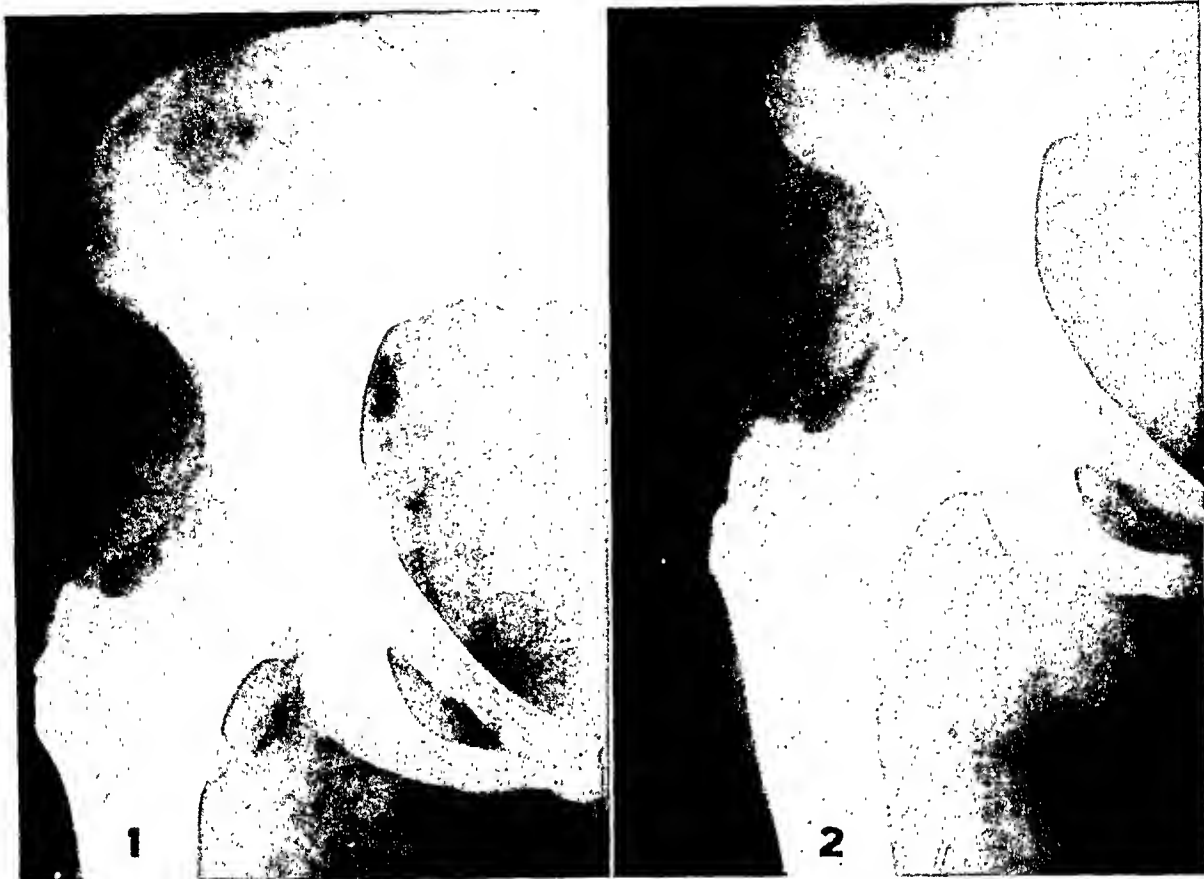
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Fig. 3. Case 2: Almost complete destruction of the greater trochanter with sequestration; irregularity and narrowing of the joint space.

#### CASE REPORTS

**CASE 1:** Mrs. J. C., a 33-year-old housewife, was admitted to the Henry Ford Hospital in February 1943, with a draining sinus in the region of the right greater trochanter. In June of 1941 she had bruised her right hip. A painless swelling developed shortly thereafter in this region, and its persistence brought her to a physician. A diagnosis of neoplasm of the right femur was made, and several deep x-ray treatments were given to the right hip before a biopsy showed the condition to be inflammatory. The patient was subsequently operated on at another hospital and placed in a cast for five months, after which she remained well until November 1942. The swelling then reappeared, and in January 1943 a sinus developed in the operative scar.

On examination the patient appeared to be in excellent physical condition. She walked without any apparent limp and without pain. There was no limitation of motion of the hip joint. In the region of the right greater trochanter was a draining sinus, with slight soft-tissue swelling and tenderness. A roentgenogram (Fig. 1) taken at this time showed a destructive process involving the greater trochanter, slight osteoporosis of the surrounding bone, and calcification in the region of the bursa. There was thought to be a possible sequestration of the tip of the trochanter. The chest film showed calcified tuberculosis.

Operation was performed on March 10, 1943, when the sinus tract and all infected tissue were excised as thoroughly as possible. The microscopic diagnosis was tuberculosis.

When last seen, in January 1944, the patient was entirely well. Roentgenograms taken at that time showed regeneration in the previously involved areas (Fig. 2).

**CASE 2:** A. S., a 43-year-old housewife, came to the hospital in January 1944, complaining of pain in the left hip. She had first noticed some discomfort in this region twenty years before admission. This bothered her occasionally, but during the past ten years it had become troublesome and a slight limp had developed. She had spent a month in bed twenty years ago, with pulmonary tuberculosis.

Examination showed slight restriction in motion of the left hip, accompanied by pain, in all directions. There was definite tenderness on pressure over the greater trochanter with some fullness anteriorly. There was also slight atrophy of the thigh.

Roentgenograms (Fig. 3) showed a destructive process involving the greater trochanter of the left femur, with calcification laterally and sequestration. There were also osteoporosis of the surrounding bone and narrowing and irregularity of the joint space. The chest film showed calcified tuberculosis in both apices.

The left leg and hip were immobilized and the patient put on complete bed rest. Operation has not yet been done because of the involvement of the joint. If this does not subside, a fusion of the hip may be necessary, along with complete removal of all infected tissue.

**CASE 3:** L. S., a 40-year-old housewife, was first seen in August 1933. Prior to admission she had undergone two operations on the left hip for drainage of abscesses, one ten and the other four years previously. Three months before admission she noticed some swelling in the trochanteric area. There had been very little pain, and this occurred at night after retiring.

Examination showed slight swelling anterior to the greater trochanter. The swelling itself was not tender, but there was tenderness over the greater trochanter. There was no limitation of motion of the hip and no pain on movement. A roentgenogram (Fig. 4) taken at this time showed a destructive process involving the greater trochanter and the cortex just below. The chest film showed calcified tuberculosis.

At operation wide excision was done and the bone was curetted. The pathologist reported a diagnosis of tuberculosis.

Following this the patient was well for a time, but the condition recurred successively in June 1934, September 1935, and again in September 1939. In June 1939 urinary symptoms had appeared and urine culture had been positive for tuberculosis. A right nephrectomy was done at that time. In September 1939 the patient began to have pain on





Figs. 4 and 5. Case 3. Figure 4 shows several areas of destruction in the left femur, in the greater trochanter, and in the cortex just below. Figure 5, five years later, shows involvement of the femoral head and neck with narrowing of the joint space.

movement of the left hip, with limitation of motion in all directions. Roentgenograms (Fig. 5) showed involvement of the head of the femur and narrowing of the joint space.

A fusion operation (arthrodesis and sliding bone graft) was done and the patient was symptom-free until late in 1941, when she was seen at another hospital complaining of pain in the left knee. There was no recurrence in the trochanter or hip at that time.

CASE 4: L. B., a 27-year-old housewife, was first seen in 1925, with enlarged cervical and inguinal nodes and a draining sinus over the right greater trochanter. These had been present for several years. The hip joint was freely movable; there was no pain on movement and only slight tenderness on pressure over the greater trochanteric bursa.

Roentgenograms (which have unfortunately been lost) showed calcification in the trochanteric bursa and a small area of destruction in the outermost portion of the trochanter. The chest film showed calcified tuberculosis.

At operation the sinus tract and all infected tissue were removed and the trochanter was curetted. The cervical and inguinal nodes were also incised and curetted. The pathological report described typical tuberculous tissue.

In 1928 a sinus tract again appeared in the region

of the trochanter and was excised. The patient had no further trouble until 1938, when a cold abscess developed in the right buttock. This was incised and drained, and the patient was not seen again.

Roentgenograms (Fig. 6) taken in 1938 showed some thickening of the bone along the greater trochanter laterally, suggesting bone production in this area. Some calcification in the soft tissues inferior to the right ischium and some irregularity of the inferior margin of the ischium were also demonstrable. These findings were believed to be due to old infection in these areas. There was no evidence of recent involvement.

#### SUMMARY AND CONCLUSIONS

1. Tuberculosis of the greater trochanteric bursa is a rare condition and is usually secondary to tuberculosis of the greater trochanter.

2. The symptoms are usually mild, and often intermittent in nature. Weight-bearing is usually painless and motion of the hip free.

3. Evidence of tuberculosis can be demonstrated elsewhere in the body in most of the cases.





Fig. 6. Case 4: Right hip ten years after operation for tuberculosis. There is slight thickening of the bone of the greater trochanter. No evidence of any recent involvement.

4. Roentgenograms show a small area of destruction of the outer margin of the greater trochanter with a surrounding area of osteoporosis. There may also be small calcium deposits in the greater trochanteric bursa, and soft-tissue swelling may be seen over this area. If the infection progresses, the roentgenograms may show involvement of the femoral head and neck, and finally of the hip joint.

5. The accepted treatment is complete extirpation of all infected tissue, with immobilization of the affected part. This is followed by body-building postoperative care.

6. The condition has a tendency to recur even after seemingly adequate treatment, with formation of a chronic draining sinus and secondary infection. Those cases in which the bursa alone is involved seem to have the best prognosis.

7. Four cases of tuberculosis of the greater trochanter and its bursa are presented to illustrate these conclusions.

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# Thoracic Manifestations of Sarcoidosis<sup>1</sup>

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THE CUTANEOUS lesions long known as *lupus pernio* and the glandular, ocular, osseous, mucous membrane, and systemic disease known as *sarcoid* were first described as one clinicopathological entity by Schaumann (9, 10) in 1914. He demonstrated clearly the lung alterations occurring in sarcoidosis which could be shown radiographically and rejected the concept that the changes were due to residues of pneumonia or to a dissemination of tuberculous nodules. He directed attention to the close similarity between the roentgen appearance in so-called chronic miliary tuberculosis and certain cases of sarcoidosis, although, in the latter, strand-like infiltrations radiating from the hilar regions were more characteristic.

It is now well recognized that the histologic unit of sarcoidosis is the so-called "hard tubercle," which consists of a collection of pale-staining epithelioid cells, with frequent giant cells, in which there is no peripheral inflammatory zone. There is no necrosis. Calcification, when it occurs, is very fine and is not conglomerate. The predilection of sarcoid tissue for the lymphatic structures in the interlobular septa explains the diffuse streaking seen in the pulmonary roentgenograms. As repeatedly demonstrated, sarcoid tissue ultimately replaces lymphoid structures. Kuznitzky and Bittorf (5) in 1915 and many subsequent authors (3, 6, 7) have further clarified the roentgenologic appearance of sarcoidosis and have shown the remarkable disproportion between massive infiltrations and minimal—frequently absent—physical signs and symptoms. Although cough and expectoration occur occasionally, febrile reactions, as a rule, are slight. Râles are rarely heard, and

only in extreme enlargement of the superior mediastinal and peribronchial lymph nodes can any dullness or modification of the breath sounds be obtained. There is a distinct tendency, in some cases, for the radiographic shadows to diminish and even disappear completely; in others, however, the shadows may persist without perceptible alterations for many years. It is not unlikely that a large number of instances of "chronic, or healed, miliary tuberculosis" belong to this group.

There have been reports of cases of right heart failure induced by diffuse pulmonary sarcoidosis (1, 8). Furthermore, the heart is not infrequently involved, and invasion of the myocardium or pericardium by sarcoid has been found in a total of 28 recorded autopsies. Recognition of these lesions during life is often impossible, due to the scattered distribution of the infiltrations. There are, however, numerous instances of cardiac enlargement which, in the absence of murmurs or hypertension, may represent myocardial sarcoidosis. Conduction defects, arrhythmias, and variable degrees of myocardial failure have been described. In two of the cases in the present group distinct cardiac enlargement appeared while the patients were under observation for systemic sarcoidosis.

Pulmonary lesions in sarcoidosis occur with great frequency. They were found in 29 of 31 cases carefully studied by Longcope (7), and this proportion has been maintained in other published series.

In a follow-up of 37 cases studied over a space of several years, King (4) found that the radiographic pulmonary lesions cleared completely, or almost completely, in 60 per cent of the cases in from seven weeks to three years, with an average of twenty-two months. Following the disappearance of pulmonary lesions, recurrences in the lung have been rare. The appearance of new lesions in the lungs, however, as hilar

<sup>1</sup> From the Medical Services and the Department of Radiology, The Mount Sinai Hospital, New York. Presented before the New York Roentgen Society in January 1944. Accepted for publication in March 1944.

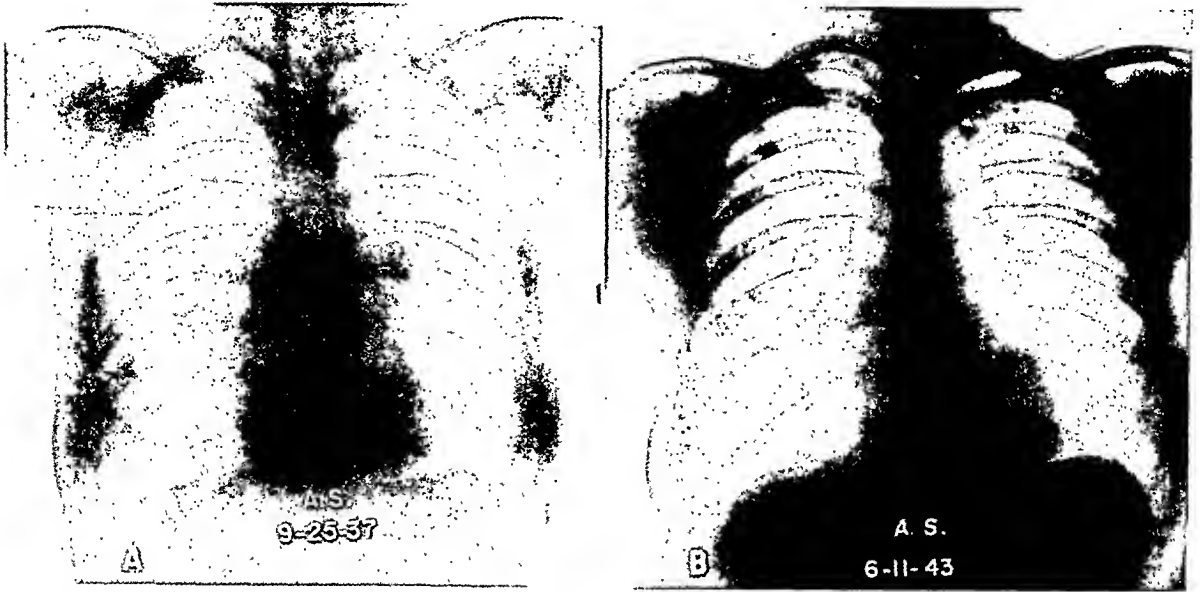


Fig. 1. Case 2. This patient had a uveoparotid syndrome (Heerfordt). Large hilar and paratracheal nodes were demonstrated in 1937. The nodes slowly receded until in 1943 there was only slight residual lymphadenopathy.

adenopathy is receding, is common. Fibrosis demonstrated roentgenologically in the mediastinal lymph nodes and lungs is not common. On the other hand, Klempner (quoted by Bernstein and Oppenheimer, 1) pointed out that hyalinization and fibrosis are found at necropsy.

The series upon which the present paper is based consists of 12 cases. Due to the close resemblance of the roentgen appearance in this disease to other conditions, chiefly tuberculosis, and the absence of conclusive radiologic features, we have not included for description any cases that were not confirmed by histologic evidence. The course of the thoracic manifestations as observed roentgenologically is not pathognomonic. Tendency to spontaneous healing cannot be deemed a diagnostic feature, inasmuch as it is observed in miliary tuberculosis, erythema nodosum, rheumatic pneumonitis, and eosinophilic infiltrations in the lungs, all of which may present a roentgen picture indistinguishable from that of sarcoid. On the other hand, pulmonary infiltrations which persist without change are not necessarily characteristic, since they may occur in diffuse but stable tuberculosis.

Since the pathologic process tends to

change constantly and organ involvement is largely fortuitous, the roentgen features are grouped only for convenience in description and not to suggest that there are corresponding static phases of the disease.

The *first group* includes cases with bilateral, frequently symmetrical, enlargement of the hilar and bronchial lymph nodes without evident pulmonary infiltration.

CASE 2: A. S., a 34-year-old woman, presented a uveoparotid syndrome (Heerfordt, 2) and generalized lymphadenopathy. Biopsies of lymph nodes, iris, and tonsils all revealed sarcoidosis. Roentgen examination of the chest in September 1937 showed huge nodes in both hilar and paratracheal areas (Fig. 1A). By November 1937 the nodes were definitely smaller and continued receding during the next year. By June 1943 there was slight residual enlargement of the nodes; pulmonary markings were slightly exaggerated, particularly in the right upper lobe, but there was no definite infiltration (Fig. 1B).

A *second group*, probably the largest, includes those cases with mediastinal adenopathy and variable degrees of infiltration into the pulmonary parenchyma. The infiltration ordinarily is strand-like and extends out more or less symmetrically from the hila. In other instances dense streaks are less apparent, but the infiltration is

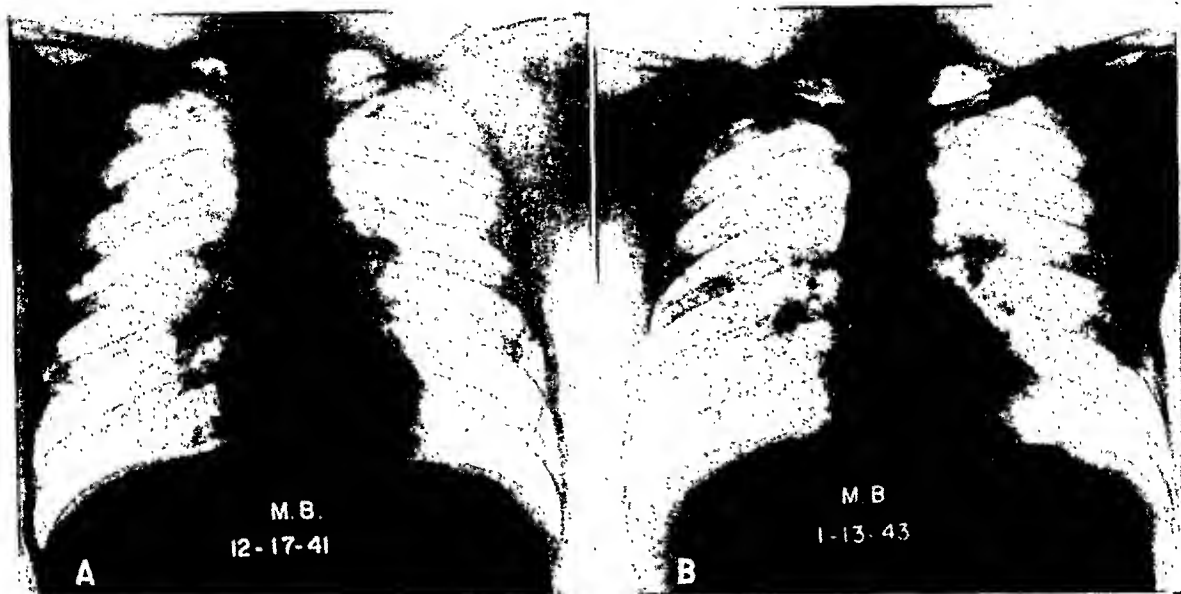


Fig. 2. Case 4. The patient was an asymptomatic male with proved sarcoidosis. In December 1941, hilar nodes were moderately enlarged. In the course of one year, the nodes receded but pulmonary infiltration became more extensive, having a reticulated appearance.



Fig. 3. Case 6. Generalized sarcoidosis with hilar adenopathy since 1936 in a colored female. By 1939, the nodes were smaller, but pulmonary infiltration was more extensive. In 1941, pulmonary infiltrations are seen to have disappeared but the right hilar and paratracheal nodes were greatly enlarged. In addition, there was a marked increase in the size of the cardiac shadow.

interlaced, resulting in a reticulated appearance. Either variety may progress into or be associated with confluent patchy infiltrations in the lungs.

CASE 4: M. B., a man of 27, was completely asymptomatic but Army induction resulted in the discovery of enlargement of the lymph nodes at the root of each lung. There was generalized adenopathy, and biopsy of a supraclavicular lymph node showed sarcoidosis. The skin reaction to tuberculin

was negative. Chest roentgenograms in December 1941 revealed large hilar nodes and slight pulmonary infiltration, especially in the lower lobes (Fig. 2A). The nodes slowly decreased in size but the pulmonary disease became more extensive. In January 1943 (Fig. 2B) the nodes were nearly normal in size but extensive reticulated pulmonary densities were present. The patient was examined last in August 1943, when the nodes were normal in size and there was perhaps slight recession in the pulmonary infiltrations.



Fig. 4. Case 7. Diffuse sarcoidosis in a female, showing faint reticulated densities in the lungs in 1937, a miliary infiltration in 1938, and more confluent densities distributed irregularly in 1942. There was increase in the size of the cardiac shadow.

CASE 6: G. P., a 45-year-old Negress, had generalized sarcoidosis including extensive lesions of the skin, lymph nodes, and bones. The skin reaction to tuberculin was negative. A positive blood Wassermann reaction was present despite intensive antisyphilitic treatment in previous years. A chest roentgenogram in April 1936 revealed enlarged hilar and paratracheal nodes. In May 1939 the nodes were less distinct and somewhat smaller, but there were diffuse strand-like infiltrations extending out from both hila (Fig. 3A). By June 1940 the pulmonary infiltrations had disappeared, but the hilar nodes were again larger. The cardiac shadow was increased. In March 1941 (Fig. 3B) the right hilar nodes were very large. Enlargement of the heart was still present.

Case 6 illustrates a recession followed by a considerable increase in the size of the hilar nodes. While the nodes became smaller, pulmonary infiltrations appeared, disappearing again as the nodes enlarged.

A *third form* of roentgen finding is represented by miliary lesions, easily simulating and often roentgenologically indistinguishable from chronic miliary tuberculosis. Mediastinal adenopathy may be present or absent, or may disappear under observation.

CASE 7: E. H., a white female of 28 years, was found to suffer from diffuse sarcoidosis and diabetic glomerulonephritis (Kimmelstiel). Inguinal node biopsy confirmed the diagnosis of sarcoidosis. The skin reaction to tuberculin was positive. X-ray examination of the chest in August 1937 revealed slight enlargement of the hilar nodes and diffuse reticulated densities in both lungs (Fig. 4A). In September 1938 the pulmonary infiltrations were miliary in type, while the nodes were unchanged in size (Fig. 4B). By December 1942 (Fig. 4C) the

miliary appearance was less distinct. There were indefinite confluent homogeneous shadows in the right upper, right lower, and left lower lobes. There was a small pleural effusion on the right side. The cardiac shadow was now enlarged. A calcified node was seen in the right hilum for the first time. The patient was examined again in March 1943, but no significant change was found.

The salient features in this case are the varying quality of infiltration, the presence of pleuritis, cardiac enlargement, and the probable association with tuberculosis as indicated by calcification of a hilar node.

A *fourth type* of the disease shows a discrete nodular infiltration with or without hilar adenopathy.

CASE 8: L. R. was a 17-year-old Puerto Rican male, complaining of moderate cough and weight loss with slight fever. There was no palpable adenopathy at the initial examination but at a later date biopsy of a supraclavicular node disclosed sarcoidosis. The skin reaction to tuberculin was negative. Roentgen examination of the chest in January 1943 revealed large hilar nodes, especially on the right side, with very slight if any infiltration of the lungs (Fig. 5A). In June 1943 the nodes were unchanged but the lung infiltrations were more extensive. By September 1943, the nodes had begun to recede but the pulmonary infiltrations had become larger. In January 1944 (Fig. 5B) the nodes were distinctly smaller, while the pulmonary infiltrations were extensive, consisting of nodules of varying size with irregular confluence.

CASE 9: J. J., a 36-year-old Negro, had diffuse skin lesions which on biopsy proved to be sarcoidosis. He complained of fever, anorexia, cough, and weight loss for three months. The Mantoux test was positive. The patient exhibited no elevation in temperature while under observation in the hospital. Sputum examinations revealed no tubercle

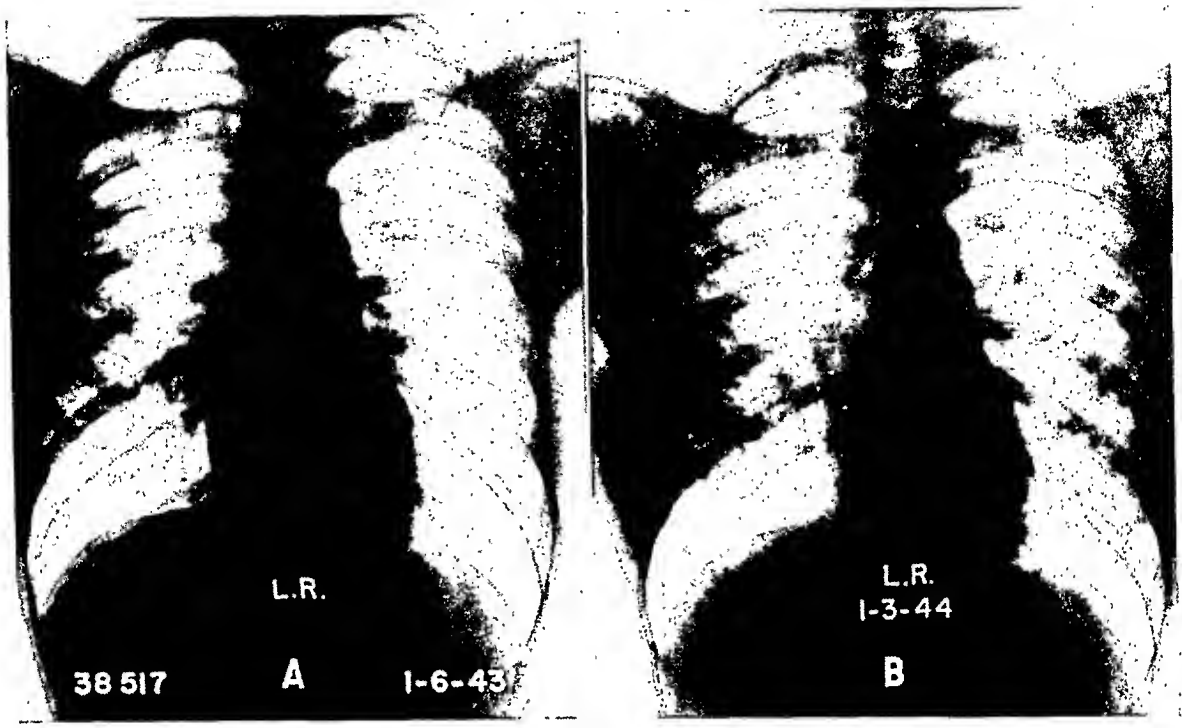


Fig. 5. Case 8. The patient was a male 17 years old with hilar and paratracheal adenopathy in January 1943. One year later, the nodes had diminished in size but extensive patchy nodular infiltrations had appeared.



Fig. 6. Case 9. Skin sarcoidosis in a male was associated with submiliary infiltrations in the lungs. These were reversible and had cleared to a considerable degree six months later.

bacilli. X-ray examination of the chest in October 1930 showed diffuse submiliary infiltrations throughout both lungs, particularly in the right upper lobe (Fig. 6A). By May 1931 the lungs had cleared considerably (Fig. 6B).

A *fifth type* of roentgen appearance is that of diffuse and confluent infiltrations

which may represent a transition from other forms of sarcoidosis and may easily simulate if not actually develop into tuberculosis. Bronchiectasis and other chronic pulmonary conditions are not easily excluded except postmortem.





Fig. 7. Cases 10 and 11. Extensive confluent and submiliary infiltrations in diffuse sarcoidosis. In these cases, it is impossible from the roentgen appearance to determine whether other disease, such as tuberculosis or bronchiectasis, is present.

CASE 10: E. Z., a white male of 19 years, had been treated for so-called Hodgkin's disease and miliary tuberculosis at the age of 14. Marked hepatosplenomegaly and focal glomerulonephritis were present. Biopsy of a skin lesion revealed sarcoidosis. Calcific shadows in the right kidney were observed roentgenologically. X-ray study of the chest in June 1929 revealed diffuse infiltrations extending out from both hila which, at the periphery, had a miliary appearance. In October 1931 the infiltrations were more extensive and more confluent. They reached out from the hila in thick, dense strands. Some suggestion of fibrosis was present and in the right upper lobe there was an emphysematous, or possibly tuberculous, cavity (Fig. 7A).

CASE 11: E. B., a Negress of 26 years, complained of fever, cough, weakness, weight loss, and expectoration for five years. Skin lesions were present with persistent adenopathy. A diagnosis of tuberculosis had been made in Baltimore, although skin biopsies failed to show necrosis or caseation. On admission to the Mt. Sinai Hospital there were diffuse adenopathy, marked hepatosplenomegaly, a positive skin reaction to tuberculin, inversion of the globulin-albumin ratio in the blood serum, and an absence of tubercle bacilli in the sputum. Biopsy of axillary nodes revealed typical sarcoidosis. A chest roentgenogram in October 1943 disclosed confluent infiltrations in both lower lobes and in the lower part of the right upper lobe, with questionable areas of rarefaction and, at the left base, what appeared to be a small cavity (Fig. 7B).

#### COMMENT

Twelve cases of proved sarcoidosis have provided the basis for review of the more frequent thoracic manifestations of the disease which are demonstrable roentgenologically. Eight examples were selected for illustration. Chronicity and variable degrees of progression of lesions with a tendency to complete healing are stressed as prominent features. Hilar adenopathy and pulmonary infiltration of strand-like, reticulated, miliary, nodular, and confluent types are found. The recession of hilar adenopathy with extension of parenchymatous infiltrations and, *per contra*, enlargement of the hilar nodes with clearing of pulmonary infiltrations have been demonstrated. Although we have somewhat arbitrarily classified the roentgen features into five groups, following Leitner (6), these divisions are used only for description, as the disease changes constantly, and transition from one form to another is the rule.

Involvement of the heart, pericardium, or both is suggested by the changes in the size and shape of the cardiac shadow.

The resemblance roentgenologically between pulmonary sarcoidosis and other conditions, particularly tuberculosis, may be so close that a diagnosis from the chest roentgenogram alone is not justified. Biopsy, when possible, is the only satisfactory basis for diagnosis.

The discussion has been limited to the roentgen features of the disease. Consideration of the controversial subjects of etiology and relationship to tuberculosis has not been included.

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# Roentgen Therapy of Mammary Carcinoma: Survival Study Based on 731 Cases<sup>1</sup>

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AS EARLY AS 1500 B.C. carcinoma of the breast was treated by excision and by a variety of escharotics, including the Egyptian arsenical pastes. Hippocrates burned out carcinoma by cautery and, though the diagnosis was probably uncertain, this would seem to be the earliest record of destruction by heat.

*Incidence:* According to Hoffman (22) the number of women dying from cancer in Massachusetts from 1920 to 1929 was 146.6 per 100,000 population. In 1935, according to the U. S. Census, cancer of the breast caused 13,226 deaths, which was 9.29 per cent of the total cancer mortality of that year. Assuming that the patient with carcinoma of the breast lives about four to five years from the time when the cancer began to the time of death, Behan (9) estimates, on this basis, that about five times 13,000, or 65,000, women (in the United States) are sufferers from mammary cancer. Spackman and Hynes (45) state that it has been estimated that 2 per cent of women die from carcinoma of the breast.

*Age (16):* According to most writers, about 75 per cent of breast cancers are in women over forty, although no age beyond adolescence seems to be immune. Brewer reported a fibroadenoma with carcinomatous areas in a Negress of sixteen years. In elderly patients the course is usually slow, and fibrosis and cicatrization are prominent. Acute carcinosis is usually found in women under thirty-five, with well developed breasts.

*Sex:* Carcinoma of the male breast is of relatively infrequent occurrence. The incidence as given by most writers is from 0.3 to 0.5 per cent of all cancers of the breast. Sachs (40) reported on 205 cases of mammary carcinoma in the male collected from various sources; 178 of the cases were proved pathologically. On the basis of this series and others recorded in the literature, he gives the ratio of male breast cancer to female breast cancer as from 0.08 to 3.0 per cent, with a mean average of 1.16 per cent. In the series from the University of Minnesota Hospitals to be analyzed here, there were 3 males, 0.41 per cent of the total number of patients.

*Heredity:* Carcinoma of various organs has been reported as having a familial incidence in from 5 to 24 per cent of cases. Maude Slye (43) found that in mice selective breeding may ultimately produce strains in which different organs or systems will acquire a definite predisposition to certain types of malignant growth. Schreiner and Stenstrom (42) discovered a familial history of cancer in 133 (24 per cent) of 563 cases of breast carcinoma.

*Lactation and Pregnancy:* Earlier investigators (9) believed that carcinoma of the breast was more frequent in women who had not borne children. Ewing (16) believed that pregnancy was without definite influence. In experimental studies, however, it has been found that in certain strains of mice the spontaneous incidence of mammary gland tumors in breeding females a year old or over is between 80 and 90 per cent, whereas in virgin females of the same age and strain it is only 50 per cent (29).

*Location:* As to the exact site of mammary cancer, a slight predominance in

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the upper axillary segment of the left breast seems to have been established by statistical studies (16).

*Trauma:* Injury may accelerate the growth of a breast cancer, and traumatism has been asserted or suspected as a causative or predisposing factor in from 5 to 13 per cent of patients.

*Estrogens:* The role of estrogens in the etiology of mammary carcinoma is the subject of an editorial by Leucutia, who believes that the estrogenic theory is not without reasonable foundation. Injected estrogenic substances (4) will cause the growth of male mammary rudiments to such an extent that fatal mammary cancer may develop, and various clinical reports indicate that pregnancy increases the rate of growth of a pre-existing breast carcinoma. Pohle and Benson (37) expressed the opinion that "roentgen sterilization of all women, regardless of age, who have metastatic carcinoma from a primary carcinoma of the breast, and of all women of forty years or older operated on for breast cancer, should be recommended as a prophylactic measure." Taylor (46) observed that "carcinoma of the breast tended to metastasize earlier in young women than in older women, and that it tended to be of a higher grade of malignancy. Postoperative recurrence seemed to take place more promptly in younger women." In 20 of 50 patients in whom an artificial menopause was induced, 20 were said to show some possible or probable benefit, while striking improvement was observed in several instances. In conclusion, Taylor states: "We are confronted with a small subgroup of young women suffering from carcinoma of the breast in whom artificial menopause has shown striking benefit. It is suggested that the presence of the ovarian hormone in these cases is almost an essential condition for the growth of the carcinoma." Archer and Cooper (7) recorded a case in a married woman of thirty in which "a highly malignant and rapidly spreading carcinoma of the breast was observed not only to be held in check but to regress to an amazing

degree" following induction of an artificial menopause. Thus, both experimental evidence and clinical observations tend to substantiate the theory that estrogenic substances accelerate the growth of mammary carcinomas and contribute to the production of early metastases.

#### CLASSIFICATION OF CARCINOMAS OF THE BREAST

Several classifications of neoplasms of the breast have been presented by various investigators. For this reason it is difficult to compare the reported results of therapy. It is important that, in comparison of statistical reports from different clinics and institutions, a universal criterion be adopted for the classification of cases. Schienck's modification of Steintal's clinical grouping appears to be simple and adequate. Stage I includes those cases where the tumor is freely movable and is strictly confined to the affected breast; Stage II, cases with firm lymph nodes palpable in the axilla and a primary breast tumor usually exceeding 3 cm. in diameter, partially fixed to the skin and underlying tissues; Stage III, the edematous and inflammatory carcinomas, with a large mass involving a considerable portion of the mammary gland fixed to the skin and underlying structures, and adherent nodes in the axilla and the supraclavicular fossa or distant metastases; Stage IV, all recurrent carcinomas of the breast.

The classification of patients and the determination of operability are not easy. Kilgore (24) stated that "palpation of the axilla is notoriously inaccurate in identifying metastases. In fact, about 30 per cent of supposedly cancerous lymph nodes felt before operation are found to be innocent, while 40 per cent of patients considered free from axillary involvement prove on clinical examination to have metastases." He adds, however, that he has not seen a hard node more than 2 cm. in apparent diameter prove innocent, nor has he seen such a node unassociated with involvement of others. Lenz (25) found

that "even large axillary masses did not always contain cancer, as exemplified by 2 out of 13 patients with axillary masses 3 cm. in diameter and larger." We believe, however, that experienced examiners usually make few mistakes in classifying patients in the proper clinical groups.

An important item to include in a statistical analysis is the age incidence in the series under consideration. Though a definite variation of incidence in age groups has been observed, the age distribution is entirely omitted from some reports. This may lead to an erroneous impression of the results of roentgen therapy, since irradiation is of limited value in highly malignant breast cancers in younger women.

Another point which appears pertinent in a survival study is the actual cause of death. Most statistics are concerned with the length of life following surgery, irradiation, or both, without regard to whether the patient died free of carcinoma. It is difficult, of course, to obtain all pertinent information after a patient's death, and it is usually assumed that factors other than the breast cancer will, on an average, contribute to the same extent to the mortality in different series. This may not be true, particularly if the series are small. The majority of patients with carcinoma of the breast are in an age group in which hypertension, diabetes, cardiovascular, blood, renal, and other diseases are also common. We decided to avoid complication of the statistics by omitting consideration of the cause of death, as the number of patients in our series is relatively large.

#### METHODS OF TREATMENT

Thirty years ago carcinoma of the breast was treated almost exclusively by surgery. Today radical operation continues to be the method of choice generally, but evidence indicating the value of irradiation therapy has accumulated rapidly so that it is now commonly employed as a supplementary procedure. The use of roentgen rays in the treatment of carcinoma of the breast may be said to

have begun in 1914, with the advent of the Coolidge tube, although as early as 1896 Emil Grubbe of Chicago treated a cancer of the breast with x-rays.

Technics and methods of treatment have changed and vary in many clinics today. To estimate the results of therapy on a statistical basis, therefore, is difficult (35, 49) and such conclusions are open to criticism. Pohle and Benson (37), Soiland (44), O'Brien (32), Spackman and Hynes (45), Pfahler (34), Schenck (41), Graham (18), Evans and Leucutia (15), Portmann (39), Bransfield and Castigliano (11), and numerous other authors have published survival statistics indicating that in mammary carcinoma of Stage II postoperative irradiation may increase the percentage of survivals from 10 to 25 per cent over surgery alone. Others (1, 8, 20, 21) have been pessimistic as to the value of irradiation in carcinoma of the breast, and have published statistics supporting their contentions. Adair (1) stated in 1943 that the improvement in survival "cannot be entirely attributed to the addition of irradiation." This same writer, however, in discussing (2) the paper by Spackman and Hynes on "Surgery and Irradiation in the Treatment of Cancer of the Breast," in 1938, reported that, in 200 patients with breast carcinoma who were subjected to preoperative irradiation, the surgical specimens as examined by Doctors Ewing and Stewart showed a total destruction of the primary tumor in 33 per cent and of the deposits in the axilla in 22 per cent.

Beach (8) reported on 5 patients preoperatively irradiated for carcinoma of the breast and stated that "careful histological study revealed persistence of the carcinoma in all of the cases," though a relatively high dosage had been administered and an adequate interval had elapsed for the full benefits of the irradiation to have taken place.

Harrington (20), reporting on surgical survival in carcinoma of the breast, stated in 1933 that "post-operative roentgen therapy is not a definite auxiliary to

surgical treatment. In selected cases in which the grade of malignancy is high it may be of value, but it is of no benefit if the grade of malignancy is low." In a later publication (21) he wrote: "The surgical results may be influenced by the use of roentgen rays and the effectiveness of the roentgenological treatment depends, to some extent, on the degree of malignancy." He concludes, however, that "roentgen therapy is of no definite aid in radical surgical treatment of carcinoma of the breast and the figures indicate that it may be detrimental to the results of surgical treatment in some cases." This conclusion is based upon a group of patients who presented no axillary nodal metastases at the time of operation, and who lived on an average of one year longer than a similar group of patients who were treated by surgery and irradiation. Harrington does not state by what method the patients were chosen for surgery and irradiation. It seems unjustifiable to subject Stage I patients with no axillary metastases to irradiation following radical mastectomy, as his own report (20) states that "71.2 per cent survived five years following operation, 52.9 per cent were living ten years, and 40.7 per cent fifteen years after operation." Harrington did not state how long after surgery irradiation therapy was given.

Pendergrass and Hodes (33), on the basis of their experiences with preoperative irradiation, "hesitate to recommend it routinely. The average duration of life in the group of patients who received pre- and postoperative irradiation was less than any other operated group." Soiland (44), on the other hand, reported a great deal of benefit from preoperative irradiation.

Adair has summarized the results obtained at Memorial Hospital, New York, with an intense series of x-ray therapy followed by radical mastectomy after a period of about three months. He found that this method gave poorer results than immediate radical mastectomy. This indicates that surgery should be performed promptly after irradiation. Our method

calls for fourteen days of preoperative treatment followed by radical mastectomy after an interval of fourteen days.

The experience in the Cancer Institute of the University of Minnesota Hospitals with preoperative roentgen therapy is confined primarily to inoperable carcinoma of the breast. For this reason the number of patients treated in this manner was small, as only a few cases became operable after irradiation. Metastases were usually extensive, and both irradiation and surgery were utilized as palliative measures.

We agree with Portmann (38), who states in his discussion of Adair's (1) paper that irradiation "prolongs life and economic usefulness." Experimental data and uniform statistical survival reports, with all forms of treatment, are the only satisfactory criterion by which we can arrive at that method which will be of the greatest benefit.

Combined operation and irradiation is the method of treatment advocated by the majority of radiologists. It postulates thorough radical mastectomy followed by irradiation adequate to destroy all cancer cells in the bed of the tumor and surrounding tissues.

Radical operations (27) have become well standardized by skilled and experienced surgeons. The mammary gland, fascia, muscles, and axillary contents are removed *en masse*. Unfortunately, however, cancer of the breast is not confined within these limits, as is evidenced by the fact that the general average of surgical curability in Stage II carcinoma, on the basis of the five-year survival rate, is approximately only 30 per cent. This means that in 70 per cent of the cases the disease had extended beyond the possibility of surgical removal by the time operation was performed.

Preoperative irradiation is being used and advocated by several well known clinics on the basis that the most highly malignant cells will be destroyed or attenuated in their growth and spread. The objections to this procedure are: (1) the necessity of a biopsy, in most instances,

for a definite diagnosis, thus opening a possible channel for spread due to surgical manipulation; (2) the postponement of surgery, which gives the cells some additional time to become disseminated.

Some surgeons question the advisability of radical mastectomy and irradiation on the basis of morbidity. At some time or another we have all seen swollen, useless arms as a result of interference with the lymph and blood flow. This complication is due to scarification in the axilla following surgery, often with postoperative infection. Whether radiation makes this condition worse is debatable. The number of patients, however, who suffer from this complication is comparatively small, although no definite statistical reports have been published to show its frequency. It may also be caused by metastasis and it is difficult to decide which factor is most important.

Fibrosis of the lungs is another complication following irradiation of the breast area, but it occurs in only a small percentage of the treated cases and seldom leads to severe disability.

Roentgen-ray sterilization for carcinoma of the breast has been advocated by many radiologists and appears to be of value in women who have not reached the climacterium. It is, however, often difficult to determine whether such a procedure will be beneficial in a given case.

Because of the frequency of recurrence in all forms of malignant growth, regardless of response to surgery, irradiation, or their combination, it is recommended that every patient with carcinoma of the breast be under observation for many years and be carefully examined at stated intervals after treatment (6).

Under the heading, "Theoretical and Biological Considerations for Postoperative Irradiation," Pfahler (34) writes: "Local postoperative treatment is intended (1) to destroy any malignant cells that may have been transplanted during operation; (2) to destroy any microscopical remnant of cancerous tissue which the surgeon may have missed, and

(3) to render the normal tissue more resistant to cancerous growth. Definite evidence of implantation is furnished by the observance of stitch hole recurrences. Other more frequent implantations probably occur under the skin flap."

For the best effect, the postoperative treatment should be started as soon as the patient's general condition and circumstances will permit, usually ten days to two weeks after operation, even though the wound is not entirely healed. Postoperative irradiation, if mild, does not interfere with healing, but the healing period may be prolonged if the doses are too large. We believe that early postoperative irradiation lessens the opportunity for carcinomatous remnants to become active lesions.

#### ANALYSIS OF BREAST CARCINOMA CASES FROM THE CANCER INSTITUTE, UNIVERSITY OF MINNESOTA HOSPITALS

We have analyzed the records of all the patients—a total of 731—who received irradiation therapy for carcinoma of the breast at the University of Minnesota Hospitals during the thirteen years, 1926 to 1938, taking the date of the first deep-roentgen-ray treatment as the beginning of the survival period. In most of the patients a radical mastectomy was performed; in a few, simple surgical removal of the breast preceded roentgen irradiation.

Cases treated in the last two years of the period covered by the report obviously would not qualify for five-year survival statistics. The entire group was included, however, in order that the report might be as complete as possible from the standpoint of symptoms and other pertinent factors.

We have been able to follow up to 1939 all except 18 patients (2.4 per cent) of the 731 treated. Some of the 18 who could not be traced at that time had been followed as long as six years. Untraced patients were considered in our statistical studies as dying from carcinoma of the breast following the last recorded information.

In some instances in this series the evidence on the records is insufficient for a definite pathological classification based on the grade system, as a considerable number of patients were referred for roentgen therapy by surgeons outside of the University Hospitals staff, and it was frequently impossible to ascertain the exact type and stage of the carcinoma. The patients who were operated upon at the University Hospitals were classified on the basis of the pathological examination of the axillary content, and Stage I cases did not, as a rule, receive radiation. It should be noted that these patients were operated upon by a great number of surgeons, among whom were many having limited experience. Because of uncertainty concerning Stages I and II, the patients have been simply grouped into three classes, as follows:

(1) Those referred for postoperative therapy, in whom the axillary nodes were supposedly involved at the time of operation and a radical mastectomy preceded irradiation by a reasonably short period. No recurrences or metastases were evident in this group at the beginning of irradiation. Since a few of these patients probably had no axillary lymph node involvement, this group includes Stages I and II (certainly not over 10 per cent in Stage I).

(2) Those patients with recurrences or metastases following either a simple palliative mastectomy or a radical mastectomy. In some of these patients, distant metastases were present but were not evident prior to operation.

(3) Inoperable cases, in which massive breast involvement existed, distant metastases were found on first examination, or the age or physical condition of the patient constituted a poor operative risk.

*Sex and Age:* Our series of cases of breast carcinoma included 728 females and 3 males. The patients were divided into age groups in one-half decades, so as to show the increase in incidence after the age of thirty-five years (Table I). Eighty-seven per cent were between the ages of

TABLE I: AGE INCIDENCE BY HALF DECADES FOR 699 PATIENTS

Age	Cases	Per Cent
20-24	5	0.7
25-29	9	1.0
30-34	28	4.0
35-39	62	9.0
40-44	92	13.0
45-49	109	15.0
50-54	111	17.0
55-59	90	13.0
60-64	69	10.0
65-69	72	10.0
70-74	28	4.0
75-79	13	2.0
80-84	10	1.0
85-89	0	0.0
90-94	1	0.1

thirty-five and seventy, and 85 per cent were over forty. The youngest patient was twenty-two years of age, and the oldest ninety-one.

These figures indicate a definite increase of patients in the higher age group (85 per cent) over the figures given by most other authors, who report 75 per cent of their patients above the age of forty years. Lewis and Rienhoff (28) found 81 per cent in a series of 950 patients to be over forty years of age and Nathanson (30), reviewing a series of 2,165 cases, reports a peak incidence between forty-six and forty-eight years.

*Symptoms and Duration:* Of the 731 patients treated, 686 gave histories of symptoms such as pain, a mass, ulceration of the breast, discharge from the nipple, etc., with a fairly accurate date of onset. In the other patients, the onset of symptoms was very indefinite or was not recorded at all in the history.

TABLE II: DURATION OF SYMPTOMS

Duration	Cases	Per Cent
1 month or less	100	15
2-4 months	148	21
5-7 months	95	14
8-12 months	114	17
Over 1 year	229	33

One hundred patients (15 per cent) had symptoms for one month or less; 357 patients (52 per cent) for one month to one year, and the remaining 229 patients (33 per cent) for over a year (Table II).

RECENT COMPARATIVE STATISTICS OF RESULTS AS COLLECTED FROM SPECIAL CLINICS (PFAHLER)

Surgery Alone, Percentage Living 5 Years				Surgery and Postoperative Irradiation, Percentage Living 5 Years			
Author	No. of Cases	Stage II	All Operated Cases	Author	No. of Cases	Stage II	All Operated Cases
Harrington	1911	25.0	33.1	Westermarck	70	38.0	37.0
Gould	151	22.0	33.1	Evans and Leucutia	175	46.3	46.1
Abell	217	26.0	46.0	Wintz	97	51.5	..
Redman	106	41.0	44.0	Lee	217	53.0	41.0
Jessop	216	30.5	43.0	Weisswang	171	27.1	53.7
Klingenstein	..	17.0	23.0	Billich	164	..	39.6
Lewis and Rienhoff	420	..	13.0	Gäbel and Magens	..	33.3	47.7
Gask	..	..	36.0	Holfelder	118	..	50.0
				Webster	353	..	42.0
				Nicolson and Berman	74	..	36.8
				Hummel	115	..	68.7
				Pfahler and Vastine	269	52.0	52.4
				[Gratzek and Stenstrom	254	..	51.0]
Average percentage		27.9	35.0	Average percentage		39.6	46.8 [47.4]

The shortest admitted duration of symptoms was two weeks before roentgen irradiation, and three days before operation. The longest duration of symptoms was forty-two years, a breast tumor having been first noticed in the year 1890. Following trauma, the mass underwent malignant change with generalized metastasis at the time of death.

*Classification of Patients:* In Table III the patients are classified into the groups

TABLE III: CLASSIFICATION OF PATIENTS IN GROUPS, WITH NUMBER OF PATIENTS REFERRED FOR TREATMENT BY YEARS

Year	Post-operative Prophylactic Irradiation	Metastatic and Recurrent Cases	Inoperable Cases	Total
1	3	12	2	17
2	13	19	2	34
3	9	12	2	23
4	22	17	1	40
5	18	29	4	51
6	27	31	9	67
7	36	25	13	74
8	42	39	9	90
9	36	29	11	76
10	33	20	17	70
11	15	18	12	45
12	32	13	17	62
13	38	28	16	82
TOTAL	324 (44%)	292 (40%)	115 (16%)	731

previously described. There were 324 patients (44 per cent) referred for postoperative prophylactic deep roentgen therapy; 292 patients (40 per cent) were

treated for recurrent and metastatic disease; 115 patients (16 per cent) were inoperable.

*Postoperative Prophylactic Irradiation:* Table IV presents the results in 324 patients (44 per cent) treated prophylactically accompanying operation: 129 patients out of 254 (51 per cent) survived five years or more and 37 out of 128 (29 per cent) survived ten years or more. It is also of interest that 6 out of 16 patients were alive after fifteen years.

The accompanying table, taken from Pfahler's publication of 1938 (34) shows comparative percentages of five-year survival in Stage II carcinoma of the breast and in all operated cases with surgery alone and with surgery and irradiation combined. The figures in our series have been added and the average has been corrected accordingly (figures in brackets).

In a subsequent paper, appearing after the publication of Pfahler's table, Evans and Leucutia (15) reported a 50 per cent five-year survival in a series of patients with Stage I and II carcinoma of the breast, treated by surgery and roentgen therapy, and a 42 per cent 10-year survival. Wintz (48) found that 48 per cent of 124 patients with Stage I and II carcinomas of the breast survived five years.

*Recurrent, Metastatic, and Inoperable Group:* No radiologist pretends to claim a high percentage of cures in those un-



TABLE IV: SURVIVAL OF PATIENTS IN GROUP WITH CARCINOMA OF THE BREAST TREATED PROPHYLACTICALLY BY IRRADIATION FOLLOWING RADICAL MASTECTOMY  
(Treated at University of Minnesota Hospitals from July 1, 1926, to Dec. 31, 1937)

Year	No. of Cases	Number of Years														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1926	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
1927	13	12	9	7	7	7	7	5	5	5	5	5	5	5	5	5
1928	9	8	7	7	6	5	5	4	4	4	3	3	3	3		
1929	22	17	11	8	6	4	2	1	1	1	1	1	0			
1930	18	15	12	11	10	8	8	7	7	7	7	7				
1931	27	21	19	15	11	11	10	9	8	8	6					
1932	36	31	29	27	25	22	19	16	16	16	14					
1933	42	39	33	32	28	24	24	24	21							
1934	36	35	28	27	25	21	21	19								
1935	33	29	26	20	18	17	16	13								
1936	15	14	12	11	9	9										
1937	32	28	26	22	20											
1938	38	32	28	22												
TOTAL	324	324	324	324	286	254	239	239	170	128	128	65	47	25	16	16
Living		283	242	210	166	129	113	99	63	42	37	17	9	9	6	6
Percentage living		87	75	65	58	51	47	41	37	33	29					

TABLE V: SURVIVAL OF PATIENTS IN THE RECURRENT, METASTATIC, AND INOPERABLE GROUPS

Year	No. of Cases	Number of Years														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1926	14	10	6	4	2	2	2	2	2	1	0					
1927	21	8	5	3	2	2	2	2	2	2	2	1	1	1	1	1
1928	14	8	3	1	1	1	1	1	1	1	1	0				
1929	18	8	5	2	1	1	1	0								
1930	33	17	9	7	1	1	1	1	1	1	0					
1931	40	19	13	11	9	6	4	2	2	2	2	1				
1932	38	16	10	5	4	4	3	2	2	2	2	1				
1933	48	29	20	11	8	6	5	4	3	2						
1934	40	25	14	9	6	2	2	2								
1935	37	22	15	6	5	3	2									
1936	30	15	5	3	1	1										
1937	30	18	8	6	5											
1938	44	28	17	8												
TOTAL	407	407	407	407	363	333	303	266	226	178	178	178	67	49	35	35
Living		223	130	76	45	29	23	16	13	9	7	3	1	1	1	1
Percentage living		55	32	18	12	9	7	6	6	5	4	2				

fortunate persons who have postoperative carcinomatous recurrences, metastases in the bones or elsewhere, or who are otherwise inoperable. Many extremely painful metastases, however, have responded so well to roentgen therapy that bedridden patients have been able to resume their household duties for months, with freedom from pain and other discomfort. Some inoperable patients have become operable following therapy, and in others recurrences have subsided satisfactorily (31).

Table V covers 407 patients (56 per cent of the total of 731) treated for recurrent, metastatic, or inoperable cancer. Of these, 223 (55 per cent) survived one year or more; 76 (18 per cent) survived three

years; 29 (9 per cent) out of 333 treated survived five years, and 7 out of 178 (4 per cent) ten years. One patient was alive fifteen years after treatment.

Among the 9 patients who survived ten years or more, there may be a few in whom metastases were incorrectly diagnosed, but in some of the group metastatic lesions were undoubtedly controlled for that period. The following is the history of a patient who was considered inoperable.

CASE HISTORY: An unmarried woman aged 45 years was referred to the University Hospitals on Dec. 22, 1933, having been aware of three lumps in her right breast and one in her left breast since 1908 (twenty-five years). She had been in the University Hospitals Out-Patient Clinic in 1913



(five years after onset) but because of the multiplicity of the nodules was advised to leave them alone, as the condition was considered benign. No biopsy was done. About October 1933 (twenty years following the first examination), the patient noticed a new "string of lumps" medially in her right breast, and on Dec. 7, she consulted a physician, who referred her to the University Hospitals.

Physical examination revealed multiple masses in the right breast with right axillary and right supraclavicular palpable nodes. One mass was present in the medial side of the left breast and a node was palpable in the left axilla. A few of the masses in the right breast were attached to the skin, and some of these were excised by diathermy on Dec. 23, 1933. Microscopic study revealed scirrhous carcinoma. On Dec. 28, radon implants (49.3 mc.) were inserted into the right breast, right axilla, and right supraclavicular regions for a total dose of 6,720 mc.-hr. During May 1934 the patient received 1,000 r (measured in air) deep roentgen therapy to the right breast, right axilla, and right supraclavicular areas, with 200 r added in the latter two regions. She was followed in the Out-Patient Tumor Clinic up to June 1937, and on Oct. 6, 1943, she was working and apparently well. It is probable that she had a benign lesion in the left breast with an inflammatory adenopathy in the left axilla, as these areas have remained dormant without any type of therapy.

This patient has so far survived almost ten years without recurrence, though no radical surgery was performed and roentgen irradiation and radon implantation were the main forms of therapy given.

Subdividing the patients into those with recurrences and metastases and those who were inoperable, we find that 292 (40 per cent of the entire group of 731) were treated for recurrent and metastatic carcinoma. There was a three-year sur-

TABLE VI: SURVIVAL OF PATIENTS WITH RECURRENT AND METASTATIC CARCINOMA OF THE BREAST

Years	Number Treated	Number Surviving	Per Cent Survival
1	292	165	57
2	292	90	31
3	292	51	17
4	264	29	11
5	251	21	8
6	233	16	7
7	213	11	5
8	184	9	5
9	145	7	5
10	120	4	3
11	89	1	
12	60	1	

vival of 51 (17 per cent) out of 292 patients treated, while 21 (8 per cent) out of 251 treated survived five years (Table VI).

The 115 patients considered to be inoperable and referred for therapy are considered in Table VII. As was previously

TABLE VII: SURVIVAL OF PATIENTS WITH PRIMARY INOPERABLE CARCINOMA OF THE BREAST

Years	Number Treated	Number Surviving	Per Cent Survival
1	115	58	50
2	115	40	35
3	115	25	22
4	99	16	16
5	82	8	10
6	70	7	10
7	53	5	9
8	42	4	9
9	33	2	6
10	33	2	6
11	33	2	6
12	7	0	

explained, these patients were considered inoperable because of acute carcinomatous involvement, an extensive local lesion and metastases, or because of being poor surgical risks. We find that 58 patients of the 115 treated (50 per cent) survived one year, 25 out of 115 patients treated (22 per cent) survived three years, and 8 patients out of 82 treated (10 per cent) survived five years.

A few of the patients became operable after an intense series of roentgen therapy, but they have been included in this group as they were definitely inoperable to start with and the later operation was considered as palliative only.

*Survival of Entire Group:* Unfortunately we do not have a follow-up on all patients with carcinoma of the breast who came to the Clinic. Some of these patients were treated by surgery alone, and the survival in this group was high, as it was made up of Stage I cases. As we have accepted all patients desiring palliative treatment, only a few persons with extensive metastases failed to receive x-ray therapy, either because they refused such treatment or because they had no complaints except from advanced pulmonary metastases. The survivals for all treated patients, independent of the extent of the disease, are summarized in Table VIII.

It is noticeable that, when no consideration as to the stage of the disease is given,

TABLE VIII: SURVIVAL IN ALL CLINICAL GROUPS OF CARCINOMA OF THE BREAST TREATED BY IRRADIATION ALONE OR IN COMBINATION WITH SURGERY (Most of Stage I cases excluded)

Years	Number Treated	Number Surviving	Per cent Survival
1	731	506	69
2	731	372	51
3	731	286	39
4	649	211	33
5	587	158	27
6	542	136	25
7	542	116	21
8	396	76	19
9	306	51	17
10	306	44	14
11	165	18	10
12	114	10	9

we have a 27 per cent five-year survival, based on a total of 587 patients treated, and a ten-year survival of 14 per cent, based on a total of 306 patients treated. No satisfactory comparison can be made with figures given by other authors, as the selection of cases differs and as Stage I cases were selectively excluded in our series. It is interesting, however, to recall that Evans and Leucutia (15) report 30 per cent five-year survivals among 830 cases treated, and 22 per cent ten-year survivals based on 434 cases. In Lewis and Rienhoff's (28) combined series of medullary, scirrhous, and adenocarcinomas, 23 per cent of the patients survived five years.

*Metastases and Recurrences:* Among the entire group of patients with records specifying the presence of metastases, the axillary and supraclavicular nodes, bones, and lungs predominate as the sites of secondary involvement. Bell (10) stated that over two-thirds of the cases show axillary metastases at the time of operation, while Trimble (47) stated that, in 80 per cent of the patients presenting themselves for examination because of a lump in the breast, metastases have already occurred. Lewis and Rienhoff (28) substantiate our observations that usually the younger the patient with carcinoma of the breast, the more susceptible she is to local or axillary recurrences.

Table IX shows the incidence of metastases for different regions and of local or

axillary recurrences. The heading "other regions" includes such sites as the omentum, intestines, peritoneum, the genitourinary system, inguinal nodes, etc., and instances specified in the records as "generalized metastases." These figures include metastases to more than one region in the same patient where mention of these is made in the record. This list cannot be

TABLE IX: SITE OF METASTASES FROM CARCINOMA OF THE BREAST

Site	Numerical Incidence
Local recurrence	54
Axillae (recurrence)	225
Supraclavicular nodes	78
Other breast	20
Lung	77
Bone	148
Skin	41
Liver	25
Brain	11
Adrenal	1
Other regions	127

considered complete but gives some information concerning the relative frequency of metastasis to different organs or locations.

In one instance metastases were found in the adrenals. The history in this unusual case is as follows:

*CASE HISTORY:* A 69-year-old white female was admitted to the University Hospitals in December 1923, complaining of pain, swelling, and blue discoloration of the left breast, occurring after a fall (Nov. 23, 1923) in which the breast was injured, with subsequent development of a mass in the upper outer quadrant. Examination revealed a mass about 4 cm. in diameter and palpable left axillary nodes. A radical left mastectomy was done on Dec. 5, and a microscopic diagnosis of scirrhous carcinoma with axillary node metastases was made. The patient made an uneventful recovery and was discharged. A roentgenogram of the chest was negative. On Feb. 21, 1927, three years later, the patient was readmitted, complaining of a lump in the left axilla which she had first noticed two weeks previously. She had a brownish discoloration of the face, neck, and hands, which had been increasing, and a small ulcer on her right forearm, which would not heal. Roentgen examinations of the gastro-intestinal tract were negative. A diagnosis of one staff physician was "acanthosis nigricans," while a dermatologist suggested "pseudopellagra," a condition occasionally seen in association with malignant growth. Four deep roentgen ther-

apy treatments were given, amounting to 800 r (measured in air) to the left breast region and 1,000 r to the left axillary region. The patient died on March 20, 1927, on the 27th hospital day.

The autopsy report described the yellowish-brown pigmentation of the skin as more intense on the exposed regions, with scaling and thickening in those parts. There was a dark brown blotchy pigmentation of the mucous membranes of the mouth. The lungs, liver, spleen, myocardium, stomach, intestines, and right kidney were normal. The upper pole of the left kidney and both adrenals were entirely replaced by metastatic scirrhous carcinoma.

This was a case of Addison's disease due to bilateral metastatic carcinoma of the adrenals with no other organs involved, except the upper pole of the left kidney, by extension.

*Bilateral Breast Carcinoma:* It is of some interest to analyze the results in patients with carcinoma of both breasts. Of the 731 patients, 9 (1.2 per cent) were found to have bilateral breast carcinoma on first examination. Eight others received treatment for carcinoma of the second breast at a later date. In a few carcinoma of the second breast may have developed after they were last examined here, as seems to be the case with one patient who stated in a letter to us that she had cancer of the other breast but considered it useless to return for further treatments. Several patients had tumors of the second breast which were either proved to be benign or could not definitely be considered carcinoma. Some authors (18) report a much higher incidence of bilateral breast carcinoma, even up to 51 per cent of their cases, but in most instances only 1.5 per cent of primary bilateral involvement.

Three of the patients with primary bilateral carcinoma had bilateral radical mastectomy. Two of them survived more than one but less than two years; the third died within a year after operation. One patient had a bilateral simple mastectomy and lived for one year. The other 5 patients were considered inoperable and received radiation therapy only. Four died within one year and the fifth three years and a half after the first treatment.

Of the 8 patients with later involvement of the second breast, 4 had bilateral mastectomy. The survival after the first and

second operation, respectively, was as follows: Case 1, 3 and 0 years; Case 2, 8 and 4 years; Case 3, 12 and 9 years; Case 4, 13 and 11 years. The latter two patients were alive and well in June 1943. Four patients had mastectomy for the original growth but were considered inoperable when they came to the clinic with involvement of the second breast. The survival from the time of operation and from first x-ray treatment to the second breast was: for two cases 1 and 0 years, for one 2 and 1 years, and for one 3 and 1 years.

These results indicate an exceedingly poor prognosis for primary bilateral breast carcinoma and in such cases radical mastectomy appears of little value. On the other hand, when a carcinoma of the second breast occurs at a subsequent date and is definitely operable, radical mastectomy should be performed and postoperative roentgen therapy given. In this group 2 out of 4 patients survived more than nine years. This seems to indicate that the second carcinoma was a new, independent growth rather than a metastatic lesion.

*CASE HISTORY:* A 41-year-old married female was first admitted to the University Hospitals in January 1930. She had noticed a mass in her left breast since 1912, which was biopsied at that time and found to be a benign lesion. In November 1929 (seventeen years later) pain and swelling occurred in the old biopsy scar. On Jan. 7, 1930, a radical mastectomy was performed and a microscopic diagnosis of adenocarcinoma was recorded. Axillary nodes were reported not involved. The patient was referred for roentgen therapy in February 1930, and 1,000 r (measured in air) were given to the left breast, left axilla, and left supraclavicular regions over a twelve-day period. There were no recurrences and no metastases up to May 1932 (two and a half years after the primary left breast lesion), when a mass was discovered in the right breast. A radical right mastectomy was performed on May 26, 1932. A pathological diagnosis of carcinoma was made, but whether any nodes were involved was not recorded. In June 1932 the patient was referred for deep x-ray therapy and was given 1,000 r (measured in air) to the right breast region with 400 r added to the axilla and supraclavicular regions; a similar series was given in August 1932. This patient survived for thirteen and eleven years, respectively, after carcinoma of the left and right breasts and, when heard from recently, was still well.

*Tumors with Short History:* In our analysis as to duration of symptoms before the institution of any therapy, 100 patients were found to have reported symptoms of one month or less. The information obtained was satisfactory enough in 79 cases to include them in a separate analysis. Forty-three of these patients came to the clinic before receiving any treatment, and 34 came with recurrences following mastectomy. It is of interest that in most of the latter patients recurrence developed relatively soon after the operation. The survivals following radiation therapy for the recurrent lesions were also relatively short, and it seems that the majority of these patients had highly malignant tumors. It was evidently rapid growth of the tumor and discomfort that brought them to a physician so soon after the discovery of the original mass. The same reason brought several of the first mentioned group to the clinic, as evidenced by 6 patients who were considered inoperable either because of metastasis or because of an inflammatory type of carcinoma. The results from surgery and irradiation in the operable cases were, however, better than usual, as the five- and ten-year survivals amounted to 60 per cent and 36 per cent, respectively. Because of the small number of patients, however, these figures are not significant. There can be no doubt that much better results would be obtained in the entire group of breast cancers if the patients came for operation immediately upon discovery of the tumor, though even under such circumstances there will undoubtedly be some who already have distant metastases.

Some investigators (28) have found that, in instances where medical care is sought very early after an abnormal growth or ulceration is noticed, the condition frequently is of an acute nature, progressing rapidly. For that reason, the patient becomes alarmed and requests aid promptly but the lesion proves to be of such a malignant nature that even the best and most thorough treatment is of little or no avail.

## TECHNIC OF THERAPY

*1. Postoperative Prophylactic Irradiation:* Prophylactic therapy was usually started about ten to fourteen days following operation, with the following factors: 200 kv.p., 30 ma., 0.5 mm. Cu and 1.0 mm. Al filter (H.V.L. 0.9 mm. Cu), focal skin distance 70 cm. The field included the anterior breast region, anterior supraclavicular, cervical and axillary regions, and the parasternal line medially. At first about 250 r (in air) was given every second day for four treatments (total 1,000 r). The intention was to repeat this series after two months, but some of the patients did not return at that time. Since 1928 additional treatments have been given to the axilla and the supraclavicular region. The dose was gradually increased to some extent and co-operation improved so that practically all patients received the dose originally planned. With these changes the results improved: 36 per cent of patients treated from 1926 to 1932 survived five years, whereas 162 patients treated from 1932 to 1937 (57 per cent) showed a five-year survival.

At the present time 140 patients receive 1.0 mm. Al and 0.25 mm. Cu (H.V.L. 0.56 mm. Cu), are large field at 70 cm. target. The full series is given over fourteen to sixteen days. During this time the above field receives 1,200 r. The axilla and the supraclavicular region receive, in addition, 300 r. The posterior chest receives 1,200 r through posterior tangential fields, 300 kv., 1.0 mm. Al and 0.25 mm. Cu (H.V.L. 0.9 mm. Cu), and the anterior chest receives additional radiation through anterior tangential fields, 300 r each. No statistics are available for this method.

Most women in the late stage of life are urged to have oophorectomy doses of deep roentgen therapy to the ovaries, being required for sterilization before operation.

*2. Recurrent:* In every such case, after the first series of treatment, the patient is followed up for a period of six months. If no recurrence is observed, a second series of treatment is given.

from the standpoint of therapy, and the amount of radiation was largely a matter of personal judgment on the part of the therapist.

3. *Inoperable Cases:* In this group of patients the involved breast was treated in quadrants, with the beam directed tangentially through the breast. The breast is divided into a superior, inferior, medial, and lateral triangular quadrant, and the patient placed in such a position as to minimize the amount of radiation striking the lung parenchyma. The anterior supraclavicular region is included in the upper breast quadrant and the axilla in the lateral quadrant. Each field was treated by a fractional dose method so that at the conclusion of treatment, between 1,000 r and 1,500 r (measured in air) had been given per field, with 200 r to 300 r (measured in air) as the maximum daily dose to one quadrant. The posterior axilla and posterior supraclavicular areas received supplementary treatment with 600 to 900 r each. The factors used were 200 kv.p., 30 ma., 60 cm. focal skin distance, 1.0 mm. Al and 0.5 mm. Cu filtration (H.V.L. 0.9 mm. Cu), with 46.4 r per minute as the output. Where indicated, a permanent sterilization dose of therapy was given to each patient who did not object to it.

*Complications and Sequelae:* Occasionally patients complained of irradiation sickness. This usually had no great significance. If it were severe, the usual dosage was diminished until the condition improved. Some of the late sequelae were lung fibrosis as a result of radiation penetrating the pleura and lung parenchyma and causing a pleuropulmonitis, as described by Desjardins (14) in 1926. Skin reactions occur rarely, and usually subside promptly after a discontinuance of therapy. Occasionally permanent telangiectasia was observed as a late sequela.

#### SUMMARY

1. In this analysis the period of survival is considered from the day of the first roentgen treatment.

2. Seven hundred and thirty-one pa-

tients were treated by deep roentgen therapy for carcinoma of the breast, 728 females and 3 males.

3. Eighty-five per cent of the patients were above the age of forty years.

4. Four hundred and fifty-seven patients (66 per cent) had symptoms of one year or less.

5. Three hundred and twenty-four (44 per cent) received postoperative prophylactic therapy, with a three-year survival of 210 (65 per cent), a five-year survival of 129 patients out of 254 treated (51 per cent), and a 10-year survival of 37 out of 128 treated (29 per cent).

6. Four hundred and seven (56 per cent) were treated for recurrent, metastatic, and inoperable lesions, with a one-year survival of 223 (55 per cent); 76 patients surviving three years (18 per cent); 29 patients out of 333 treated surviving five years (9 per cent), and 7 out of 178 (4 per cent) surviving ten years.

7. Metastases were most common in axillary nodes, bones, the supraclavicular region, and lungs.

8. Early diagnosis and immediate irradiation therapy following radical mastectomy gave the best results.

9. Lung fibrosis as a complication can be minimized if a suitable technic is selected and fields are properly rotated.

#### CONCLUSIONS

Carcinoma of the breast is still a cause of death in a high percentage of the population. Early diagnosis, with immediate radical surgery followed by adequate deep roentgen-ray therapy, or operation preceded by irradiation, produces the most favorable results known today. Statistics from various clinics show a much higher percentage of five- and ten-year survivals with this combination than with surgery alone in Stage II carcinoma of the breast.

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# Roentgen Therapy in Diseases of the Blood-Forming Organs<sup>1</sup>

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WHILE ROENTGEN therapy is recognized as the best symptomatic treatment available for leukemia, Hodgkin's disease, and similar conditions, there is apparently no standard method of irradiation. The details appear to differ in some respects with each roentgenologist. The present study was undertaken to determine the actual results of treatment and, if possible, to account for the remarkable difference in the outcome in different patients. The physician tells the roentgenologist: "This patient has leukemia" (or Hodgkin's disease, or some related condition) and asks: "Will you treat him?". The resultant treatments are of many types.

The case histories of 980 patients with diseases of the blood and blood-forming organs, receiving roentgen therapy, were reviewed to note the effect of different factors on the results. The diseases included various stages of myelogenous, lymphatic, monocytic, and atypical-cell leukemias, types of Hodgkin's disease, and lymphosarcoma. Statistical data will be published in another paper, but certain results of the analyses are given here, with case reports illustrating the essential points.

The x-ray therapy received by these patients represented the current practice of roentgenologists from numerous sections of the country, many of the patients having been treated in other clinics and hospitals before they were examined by us. Treatments were of many types, and it was extremely difficult to compare the effects of similar doses, whether stated simply as the number of roentgens or with all the technical factors. There appears to be no way at present of representing what was done to one patient in terms in any way comparable to what was done to another.

From the state of the patient, his blood, or other factors, it was impossible to predict from a study of the records what a given series of x-ray treatments would do, as the techniques were so varied. Some excellent remissions were recorded, whereas in other patients an exacerbation of the disease process resulted.

In actual practice, remissions last for varying times, from days to months. It is of practical importance to note what factors in the treatment or the condition of the patient influence their length and degree. Among the variable factors which could be analyzed were: stage of the disease (duration to the present time), the leukocyte count, maturity of the cells in the blood, maturity of the cells in the marrow, red blood cell count, platelet number, tendency to bleed, fever, age of patient, sex, number of previous relapses, previous treatment (irradiation), kinds of accessory treatment, lymphocyte count, basal metabolic rate, total "dosage" of x-ray (r), method of application, frequency of exposure, number of days in which treatment was given, parts irradiated, and size of field.

In analyzing the effects of treatment the following factors were taken into consideration: symptomatic remission, temperature decrease, increase or decrease in the leukocytes, increase or decrease in red cell count, platelet number, length of remission, change in weight, basal metabolic rate, pulse rate, uric acid output, chemical changes, bone marrow changes, peripheral blood changes, and re-establishment of the menstrual periods.

## INTERVAL OF DOSAGE

In the following case of chronic myelogenous leukemia a comparison is made between giving doses of 200 r on alternate days (total 1,600 r in sixteen days) and

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.



giving 800 r on three consecutive days and one exposure three days later (same technical details of dosage). (This last dose should have been grouped with the others.) No demonstrable remission was produced in the first series, but a remission of about three months followed the second series. These two types of dosage interval were encountered frequently in the series of patients with results very much like those shown in this patient. Case II illustrates the short remissions when the alternate day interval is used.

CASE I: Man, age 38 years. Chronic myelogenous leukemia. Treatments over the spleen area. The blood counts on any given day were taken before the treatments were given. They were as follows:

Day	Leukocytes per Cu. Mm.	X-ray Irradiation to Spleen Region
-5	222,600	...
-4	161,600	...
-3	172,200	...
-2	157,000	...
-1	284,400	...
0	239,200	200 r
1	238,800	...
2	216,600	200 r
3	175,800	...
4	192,800	200 r
5	183,800	...
6	204,600	...
7	155,400	200 r
8	152,000	...
9	124,000	200 r
10	132,200	...
11	118,200	...
12	134,200	200 r
13	129,200	...
14	168,000	200 r
15	102,600	...
16	150,400	200 r
17	100,800	...
18	121,000	...
19	96,800	...
20	103,600	...
21	79,600	...
22	148,400	...
23	115,800	...
24	83,000	...
25	134,000	...
26	128,000	...
27	134,000	...
28	150,400	200 r
29	103,400	200 r
30	140,600	200 r
31	91,800	...
32	122,000	...
33	103,800	200 r
34	66,200	...
35	77,000	...
36	75,200	...

Interval of 95 days

131	224,400	...
132	276,200	...
133	249,200	...

SIZE OF THE FIELD IRRADIATED

With the same technical factors, variation in the size of the field (area of skin exposed) appears to be important. Thus 200 r over a large field produces a much greater effect than the same number of units over a small area. This is especially evident when fields of two sizes are used on the same patient at different times. It is, of course, shown quite well when adequate "spray" technique is used as compared to a limited area.

AREA EXPOSED. CHEST AND SPLEEN REGION: EFFECT OF TOO SMALL A DOSE

A relapse may be instituted if a small dose of x-ray is given or if it is given over an area where it affects much of the bone marrow directly.

CASE II: Man, age 34 years. Chronic myelogenous leukemia. The patient had a severe paroxysmal cough, which did not respond to sedatives or cough medicines of any type. His leukocyte count was 15,400 per cu. mm. with most of the cells of fairly mature types. He was treated over the anterior surface of the chest, through a 15 X 15-cm. field, and later over the spleen (10 X 5 cm.). The leukocyte changes are shown in the following table. At the beginning of the treatment the patient was in a remission induced by Fowler's solution.

Day	Dose in r	Leukocyte Count	Area Exposed
1	35	15,400	Chest
4	50	14,500	Chest
11	50	17,500	Chest
12	60	19,500	Chest
16	50	18,000	Chest
22	..	21,000	...
Interval of 27 days			
49	..	255,000	...
54	75	175,000	Spleen
57	75	140,000	Spleen
61	..	54,000	...
70	..	21,400	...
Interval of 26 days			
96	..	226,000	...
103	..	261,000	...
104	75	...	Spleen
106	75	206,000	Spleen
109	75	155,000	Spleen
113	75	90,000	Spleen
120	..	32,500	...
Interval of 19 days			
139	..	141,000	Fowler's solution
153	..	136,000	...
181	..	76,600	...



Day	Dose in r	Leukocyte Count	Area Exposed	Day	Leukocyte Count	X-ray (Spleen Area, Anterior and Posterior)
<i>Interval of 174 days</i>						
355	..	72,800	...	-4	152,400	...
363	50	80,000	Chest 15 X 15 cm.	0	...	200 r
366	70	52,200	...	1	...	200 r
369	70	60,000	...	2	...	200 r
371	90	100,000	...	3	...	200 r
376	100	203,000	...	4	...	200 r
378	100	288,000	...	10	125,200	...
380	30 spray	352,000	...	16	184,000	300 r
383	..	237,000	...	17	191,000	300 r
411	..	352,000	...	18	166,500	...
				19	109,000	...
				20	78,800	...
				27	28,300	...
				31	14,800	...
				35	9,300	...
				42	5,800	...
				45	3,800	...
				48	5,900	...
				52	2,900	...
				56	3,000	...
				63	5,100	...
				70	8,600	...
				73	23,700	...

*Remission for over eight months*

No great change in the leukocyte count was noted during the treatment over the chest, the white blood cell count during this period being but slightly above normal. A complete relapse followed, however, during the next four weeks. Here, comparatively "small" doses were given, not on consecutive days (five exposures in sixteen days, total 245 r). Two exposures over the spleen (not on consecutive days, 150 r in three days) caused a reduction to 21,400 leukocytes thirteen days later, followed by a complete relapse within the next three weeks. Four more treatments over the spleen (during nine days, total 300 r) reduced the leukocyte count to 32,500 in two weeks, but there was again a complete relapse in nineteen days. A remission was produced and maintained for eight months by the use of Fowler's solution.

As the patient's cough was severe, it was decided to try more x-ray therapy over the chest. The leukocyte count at this time was 72,800, the cells were mostly metamyelocytes, young and mature neutrophils, and from a hematological point of view the blood was in a comparatively good condition. Seven x-ray treatments were given at three-day intervals over seventeen days (total 510 r) and a complete relapse followed.

This patient should have responded perfectly to adequate treatment with x-rays as he did with Fowler's solution. His blood cells were in stages known to respond best to roentgen therapy, but the results were those of "stimulation" rather than depression.

#### PRODUCTION OF LEUKOPENIA

There is apparently no permanent harm if leukopenia is produced after x-ray therapy in chronic myelogenous leukemia. There may, however, be a prolonged reduction of the number of the red blood cells, white blood cells, or platelets, varying in different patients.

CASE III: Man, age 38 years. Myelogenous leukemia. The leukocyte counts in this patient were as follows:

The depression in the leukocyte count lasted three weeks. There was a mild depression of the red cell count after the first five treatments, and again from the thirty-fifth to the fifty-sixth day. The platelets, which had been increased in number before therapy, were reduced in number after the fifth day and did not recover for about two months, reaching a low normal after that, with occasional periods of depression.

#### APLASIA OF RED BLOOD CELLS AND LYMPHOCYTES

CASE IV: A man, age 49 years, felt well until about two weeks before he came to us for examination. At another hospital it had been noted that he was pale and weak and had a mild fever. A biopsy section of a lymph node was interpreted there as a malignant tumor, a reticulum-cell sarcoma or metastatic carcinoma. (The disease was reticulum-cell sarcoma or "Hodgkin's sarcoma.") In the preceding eleven days he had received roentgen therapy, 1,850 r, over the inguinal, axillary, and left supraclavicular regions. This treatment proved quite toxic and the lymphocytes decreased to 440 per cu. mm. on the last day of the treatment, falling to 53 per cu. mm. during the next six weeks. The red blood cells decreased somewhat more slowly, but reached 1,800,000 in four weeks. The neutrophils did not decrease proportionately, but reached their lowest point in about the same time (1,350 per cu. mm.). A study of the bone marrow cells showed almost complete aplasia of the red blood cells, but a fair amount of neutrophilic leukocyte material remained. Improvement in the leukocyte count (lowest point, 2,000 per cu. mm. four weeks after the treatments) and in the red cell count followed blood transfusions, but the lymphocytes did not recover.

The blood platelets, increased in number at first, as is characteristic of Hodgkin's disease, became slightly reduced in number, and eventually recovered. Peritonitis developed from a ruptured duodenal ulcer, and a characteristic polymorphonuclear leukocytosis (neutrophils, 93 per cent of 19,200) occurred.

This case illustrates the fallacy of treating the disease rather than the patient. It shows the order in which toxic effects on the cells become evident and the order of recovery, when the lymph node areas are irradiated. Under the circumstances, the platelets resisted the treatment more than the other blood cells.

#### STATUS OF THE PERIPHERAL BLOOD AND THE BLOOD-FORMING TISSUES

The height of the leukocyte count in the peripheral blood and the degree of the maturity of the cells were factors in determining the effect of the treatments only to the extent that they represented the true status of the marrow, lymph nodes, or spleen. This is, of course, evident in the aleukemic forms, where the blood-forming tissues are hyperplastic and the peripheral blood shows a normal or leukopenic state. However, in patients with elevated leukocyte counts, the marrow at times harbored extensive nests of blasts while the peripheral blood showed comparatively few. In these cases, treatment with x-rays produced a poor or short remission, followed by an exacerbation. In such cases the number of blasts in the blood usually increased after irradiation, with progressive anemia. Frequently, when blasts formed about 5 per cent of the peripheral cells, the prognosis was uncertain, but when the percentage rose to 10 or higher, the effect of irradiation was either transient or deleterious. There was some suggestion that blood transfusion improved the prognosis in many cases that otherwise would have been expected to show a poor response. As a rule, the patient had a better chance of a remission when the blood cells were metamyelocytes or older in myelogenous leukemia, small lymphocytes in lymphatic leukemia, and young or mature monocytes in monocytic leukemia, than when the cells

were younger, unless too frequent small doses of x-ray were given over long intervals.

#### RED BLOOD CELL AND PLATELET COUNT

A low red blood cell or platelet count was not in itself a prognostic factor in treatment. When the red blood cell tissue was active in the marrow, but crowded, improvement followed adequate reduction in leukocyte tissue following irradiation. A temporary fall in the red cell count was noted frequently after x-ray therapy by several of the different methods. This may have been the result of injury of the red blood cell tissue by the x-rays, or it may have reflected the increased rate of growth of the marrow (leukocyte tissue), which constituted the first change after irradiation, before the reduction started. In patients with adequate red blood cell growth (no room to mature beyond the normoblast stage), anemia was not a contraindication to x-ray therapy. When red blood cell tissue was depressed (acute leukemia: "blast" leukemia) x-ray irradiation caused a further anemia and was definitely contraindicated. It was evidently very difficult in many cases to evaluate this from the blood films alone, whereas in others it was quite obvious.

The platelet number in the peripheral blood did not, in itself, serve as a direct guide to treatment. Reduction in the platelet number was a contraindication to therapy only when accompanied by many leukocyte blasts in the peripheral blood. Many patients with chronic lymphatic leukemia and platelet reduction with anemia responded well to therapy. Failure in the manufacture of platelets was a definite contraindication to irradiation.

#### BASAL METABOLIC RATE

As a rule, the degree of activity of the leukemic process was reflected in the elevation of the basal metabolic rate. A simple clinical guide was the elevated pulse rate, but irritability, excessive perspiration, and loss of weight were other evidences. In those patients with fairly

mature cells in the blood and blood-forming organs, the high basal metabolic rate was an adequate guide for x-ray therapy, as the increased use of oxygen represented the degree of activity of the leukemic process. When many blasts were present, however, the basal metabolic rate alone was not an adequate guide.

#### AGE AND SEX

From the present analysis, it is not possible to formulate a definite statement as to whether an older or a younger person with the same degree of leukemic involvement responds better to x-ray therapy. The extremely wide range of responses may have been related to the many methods of irradiation. The problem will bear further study. Excellent remissions as well as poor ones were encountered in both young and old and male and female, with comparable conditions of the blood.

#### FEVER

An analysis of the case histories indicated that fever in itself was not a contraindication to x-ray therapy. The degree of advancement of the leukemia and the degree of immaturity of the cells were more potent factors, when accompanied by fever, than the mere elevation of the temperature. As a rule, extremely high temperatures ( $104-106^{\circ}$ ) accompanied conditions which in themselves would have ruled out x-ray therapy.

#### FIRST AND SUBSEQUENT REMISSIONS

An analysis of the cases shows that a second remission induced by roentgen therapy may be as long as the first or longer, although as the disease progresses there is a tendency for subsequent remissions to be shorter. The following case history shows a remission of three months following a remission of one month. A later remission of over fourteen months was induced by the use of Fowler's solution.

CASE V: Woman, age 43 years. Chronic myelogenous leukemia, with a previous duration of about

five years. The leukocyte count at the beginning of therapy was 89,200 per cu. mm. Treatments, twelve in number, were given over an area  $20 \times 20$  cm. on the abdomen in the course of five weeks, 25 r each time (total 300 r). The lowest point in the leukocyte curve after this treatment was 32,000 per cu. mm.; four weeks later the count had risen to 85,400, and in two more months to 144,000 per cu. mm., with a red blood cell count of 1,740,000. Although the prognosis seemed hopeless at this time, the patient was given three exposures alternating over the anterior and posterior surfaces of the spleen area, 30 r on three consecutive days (field  $20 \times 20$  cm., total 90 r). There was a rapid fall in the number of leukocytes to 33,000 per cu. mm., and the remission lasted for four months. The leukocyte count then rose to 96,000. The count fell after the use of Fowler's solution and for the next fourteen months the leukocyte and red blood cell counts were normal, no treatment of any kind being used during this period. Subsequently there was a relapse associated with a high leukocyte count, great immaturity of the white cells, and hemorrhage into the brain, followed by death.

#### SUMMARY AND CONCLUSIONS

In the cases studied the diagnosis was usually made by the physician and it was left to the radiologist to plan and give the x-ray therapy. In many cases a hematological remission was not produced, or was obtained only after weeks of therapy. If a relapse followed soon after, it was often attributed to the vagaries of the disease. Yet it is known that many patients with fairly mature blood cells do respond well to proper therapy. It is our impression from the cases studied that it takes a longer time to produce a remission when the treatments are given on alternate days or at three-day or one-week intervals, and the remissions are shorter, than when the dose is given on successive days and discontinued when the leukocyte count falls to between 60,000 and 80,000 per cu. mm.

The factors of anemia, fever, and platelet number are not of primary significance in themselves as contraindications to x-ray therapy, but are useful in evaluating the underlying conditions. When a decrease in the number of red blood cells or platelets is an expression of the crowding of the marrow with fairly mature leukemic cells, roentgen therapy is indicated and is of value. When the anemia and thrombocytopenia reflect the crowding of the

marrow with blast cells, irradiation is definitely contraindicated. With the same number of r, the effects are more pronounced, the larger the field, and the results vary with the region exposed. Leukopenia after x-ray therapy is not necessarily permanently harmful. The status of the cells in the marrow, spleen, or lymph nodes is the underlying factor which determines whether or not the response is good, and this characteristic may or may not be

evident from the peripheral blood. Age and sex in themselves are apparently only secondary factors in the prognosis. The basal metabolic rate, in so far as it indicates the degree of activity of the leukemic process is a guide to therapy, unless there is gross immaturity of the cells (predominantly myeloblasts, lymphoblasts, or monocyte blasts).

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# The Experimental Production of Extraskkeletal Bone-Forming Neoplasms in the Rat<sup>1</sup>

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BONE-CONTAINING neoplasms which have no connection with the skeleton are occasionally observed in man. Raso (1), in 1937, reported an osteoid chondrosarcoma of the breast and collected from the literature, dating from 1835, 74 mammary gland tumors containing bone or cartilage. Of the malignant tumors in this group, 27 were osteosarcomata, chondrosarcomata, or osteochondrosarcomata, 7 were primarily carcinomata, and 5 were mixed tumors. Binkley and Stewart (2) in 1940 discussed 9 cases of tumors of epithelial origin resembling osteogenic sarcomata and concluded that the most important alterations leading to the appearance of the structure of osteogenic sarcoma are the laying down of dense hyaline tissue and the development of a cavernous telangiectatic type of circulation favoring stasis. They recognized that these features fail to explain the structure of cartilage in these so-called mixed tumors. Allen (3), 1940, described 4 mixed tumors of the mammary glands of dogs and one from the human breast. He concluded that in 3 of the canine neoplasms the cartilage was derived directly from adult epithelium. The strikingly high incidence of bone and cartilage in breast tumors of dogs he ascribed to liability to trauma and the rectiform pattern of the canine acinar epithelium. Wilson (4), 1941, collected from the literature 30 cases of malignant bone-forming tumors of the soft tissues with histologic pictures of true osteogenic sarcomata and added 10

new cases as illustrations of the totipotency of neoplastic mesoblastic tissue. The literature contains numerous additional descriptions of bony and cartilaginous neoplasms of the thyroid, uterus, ovary, lung, pleura, kidney, bladder, fascia, and meninges.

The first experimentally produced osteosarcoma was reported by Russell (5) in 1923. He described an osteosarcoma of the subcutaneous tissues of a rat at the site of repeated tar injections. The neoplasm was observed six months after the cessation of injections and was a polymorphous-cell sarcoma with bony particles scattered throughout the growth. It was readily transplantable, but osteoid tissue was found in only two growths of the first generation of transplantation. In these two instances the tumors had grown slowly, persisting for ninety-three and ninety-eight days, respectively. Russell concluded that the metaplasia required a long period to unfold itself and that its absence in subsequent generations could be attributed to the rapid growth of the soft tissue, which generally destroyed the rats long before three months had elapsed.

## CYSTICERCUS-INDUCED NEOPLASMS

In 1925, Bullock and Curtis (6) reported 4 experimentally induced tumors in the rat's liver which contained hyaline cartilage. These tumors were observed in a series of 1,400 *Cysticercus*-induced neoplasms and included one osteoid chondroma (the only benign neoplasm in the series), a chondrosarcoma, a mixed-cell sarcoma containing islands of cartilage, and an osteochondrosarcoma. In the latter case osteoid tissue, bone, and cartilage were identified in the peritoneal metastases. A fifth *Cysticercus*-induced bone-

<sup>1</sup> This study was undertaken under the direction of Dr. F. C. Wood at the Department of Cancer Research Columbia University, to whom the authors gratefully acknowledge their indebtedness for interest and encouragement. The paper was read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

<sup>2</sup> Fellow of the Detroit Branch of the Women's Field Army of the American Society for Control of Cancer.

forming tumor was made the subject of a separate report (7). This was the sixth bone-forming tumor in a series of 2,100 induced neoplasms and was unique in being composed in part of malignant bile-duct epithelium. The bulk of the tumor was osteochondrosarcoma of rather diversified structure, containing a large proportion of cartilage, osteoid tissue, and bone of the trabeculated type without lamellations. The intercellular substance was of several different kinds, embracing fibrillar, hyaline, osteoid, cartilaginous, and osseous material. Intermingled with the intercellular substance were tumor cells in different stages of differentiation and showing wide variation in size. Some parts of the growth consisted solely of large polymorphous cells and toward the periphery the sarcoma merged into carcinomatous tissue. The carcinoma was composed for the most part of rather small, deeply staining euboidal cells which showed a tendency to arrange themselves into alveoli, small groups or strands occasionally forming the lining of small acini. The carcinoma replaced a part of the wall of a Cysticercus cyst and infiltrated the liver. The host showed generalized peritoneal metastases, but only the diaphragm was examined microscopically. This showed the structure of a polymorphous-cell sarcoma and contained islands of osteoid tissue and bone. The rat had, in addition, two other transformed cysts of approximately equal size. These had the structural characteristics of polymorphous-cell sarcomata and were probably of independent origin. The two types of tissue in the mixed tumor were thought to represent independent processes, since there was no evidence to indicate that the sarcoma resulted from a malignant transformation of the stroma of the carcinoma.

In subsequent studies, bringing the number of Cysticercus-induced neoplasms observed in the rat's liver up to nearly 7,500, there were identified 43 additional bone-forming tumors. In this entire series, therefore, 49 or somewhat less than 1 per cent of the liver tumors contained bone,

TABLE I: MEAN LATENT PERIOD AND STANDARD DEVIATION OF A GROUP OF CYSTICERCUS-INDUCED NEOPLASMS AND THE NUMBER AND AVERAGE LATENT PERIOD OF THE BONE-FORMING TUMORS WITH THE SAME NUMBER OF CYSTS

No. of Cysts	Days/30		Number of Bone Tumors	Average Latent Period Days/30
	Mean	S. D.		
1	18.8	3.8	6	18.9
4	17.4	3.4	8	15.6
7	16.6	3.2	8	17.2
10	16.5	2.5	1	16.3
13	15.5	2.3	6	16.6
16	14.5	2.4	4	17.9
19	13.9	2.4	2	12.0
22	14.5	1.9	5	14.8
25	14.6	2.3	2	17.3
28	13.7	2.2	3	14.2
30-34	13.3	1.8	1	11.9
35-39	13.5	1.9	1	9.0
40-44	13.6	1.7	.	..
45-49	12.8	1.6	.	..
50-54	12.9	1.7	1	12.6
55-59	12.7	1.5	.	..
60-64	12.2	1.9	1	12.3

cartilage, or osteoid tissue; 21 resembled true osteogenic sarcomata; 26 were primarily fibrosarcomata containing islands of osteoid tissue, bone, or cartilage; 2 were benign chondromata. These observations are of especial interest in view of the results obtained by Huggins (8) in a series of well controlled experiments on heteroplastic bone formation in dogs following the transplantation of bladder epithelium. Huggins found that transplants of epithelium from the urinary bladder separated from their own fascia invariably initiated bone formation in the rectus muscle, subcutaneous tissues, fascia lata, and synovial cavity of the knee joint, while in the parenchyma of the kidney, liver, or spleen the regenerating epithelium formed cysts surrounded by similar appearing connective tissue but no bone. These experiments demonstrated the nonspecificity of osteoblasts, since other connective tissue under an altered environment acquired osteogenic properties, but Huggins concluded, further, that there are two types of fibrocytes: those which ossify, such as the connective tissues of the fatty-fibrous subcutaneous tissue, striated muscle, and fasciae, and those without the capacity to ossify, from the kidney, liver, and spleen.

Obviously the fibroblasts of the liver

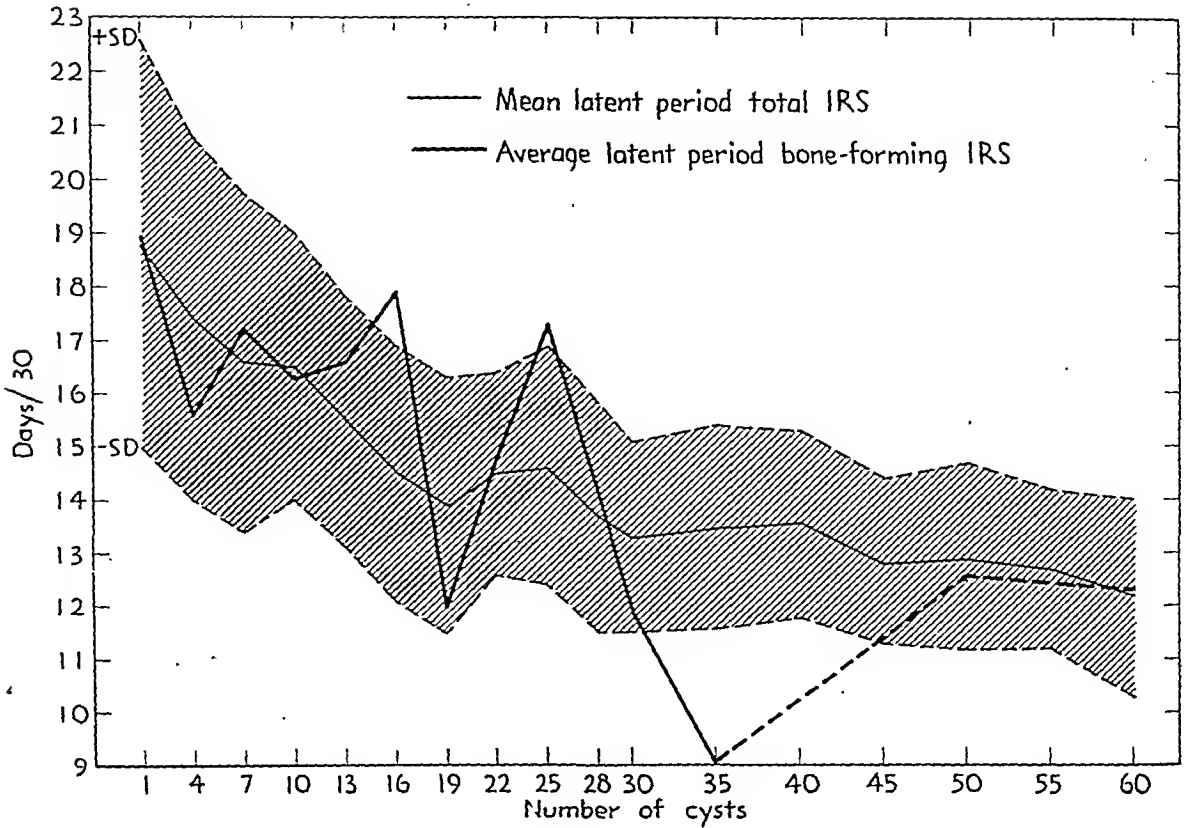


Chart 1. The mean  $\pm$  S. D. latent period of *Cysticercus*-induced neoplasms and the average latent period of *Cysticercus*-induced bone-forming tumors.

of the rat may assume osteogenic properties under some as yet obscure conditions. Inspection of the available data on the 49 neoplasms mentioned above failed to reveal any contributing factor. These rare neoplasms were observed in rats infested with from 1 to as many as 64 *Taenia* larvae and were distributed among each of the several lobes of the liver as follows: right median 19, right lateral 9, left median 7, left lateral 7, caudate 4, hilus 1; in 2 instances the exact location was undetermined. The hosts were of 5 different inbred strains, represented as follows: A  $\times$  C, 17; Fischer, 10; Copenhagen, 7; August, 6; Zimmerman, 2; hybrids 7, approximating the proportional distribution of the tumor-bearing rats of the colony, which practically eliminates the possibility of an hereditary constitutional factor. Thirty-six of the tumors were observed in male and only 13 in female rats, but in a population (9) in which the males were previously shown to have 17 per cent

more parasitic cysts than the females this difference is probably not significant.

The average latent period is dependent upon the number of parasitic cysts and, as shown in Table I and Chart 1, when the latent periods for the tumors of this small group are compared with the mean latent periods previously observed (10) for nearly 4,000 *Cysticercus*-induced sarcomata, it appears that this group shows more than the expected range of variation for tumor bearers with the same number of cysts. In 3 instances the average fell outside the area bounded by the mean  $\pm$  the standard deviation. In 8 of the 14 classes the average latent period of the bone-forming tumors was longer than that observed for the large group. In spite of the evidence which follows, however, it cannot be convincingly argued that the process of osteogenesis requires a longer time or that an exceptional parasite elaborating less incitant was a determining factor, since in a few instances these bone-forming tumors



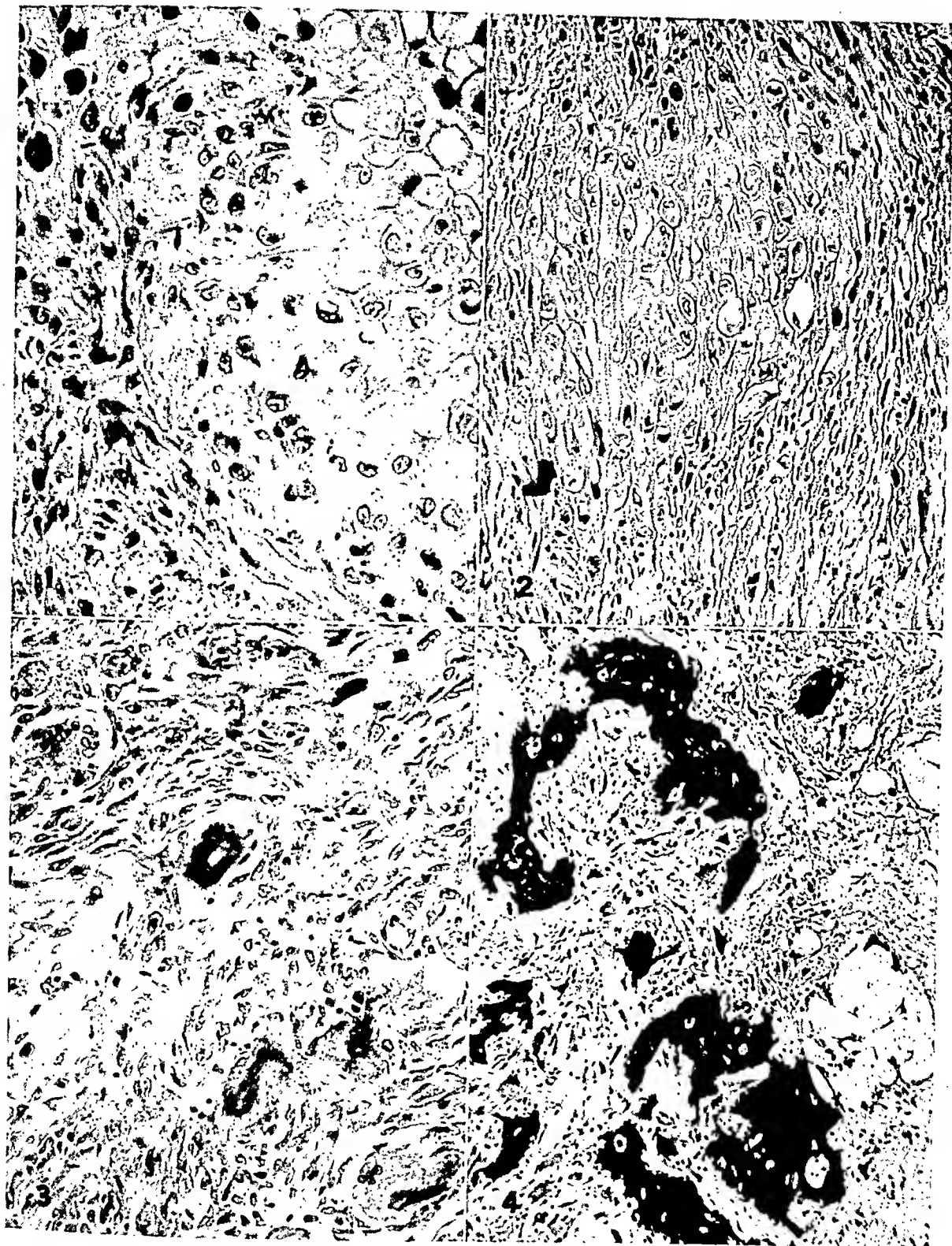


Fig. 1. Chondrosarcoma of rat (Tumor B-P 1163)  $\times 260$ .  
 Fig. 2. Fibrosarcoma with islands of osteoid tissue (Tumor B-P 1696)  $\times 260$ .  
 Fig. 3. Fibrosarcoma with areas of bone formation (Tumor B-P 1813)  $\times 260$ .  
 Fig. 4. Fibrosarcoma with areas of calcification (Tumor B-P 2159)  $\times 150$ .

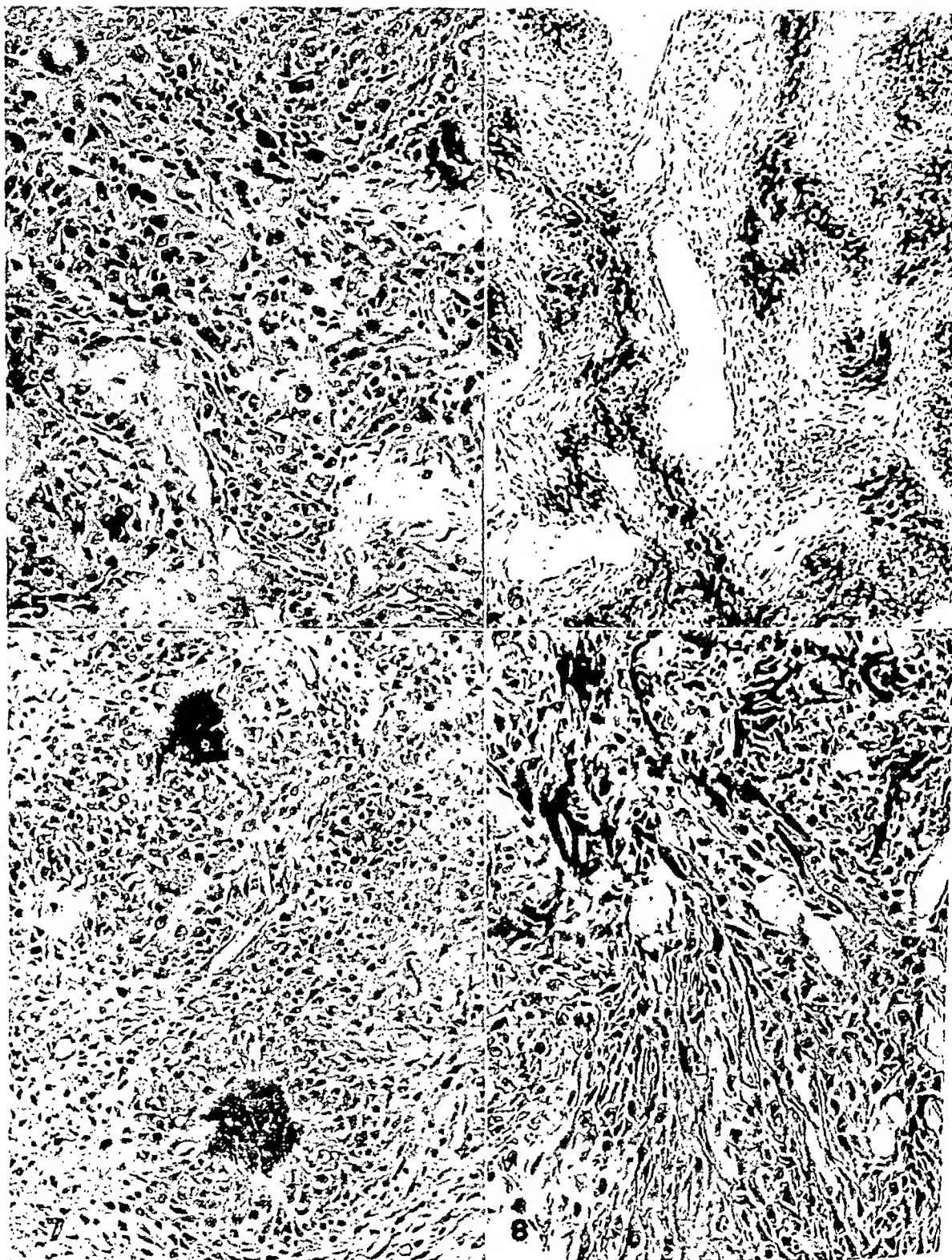


Fig. 5. Osteosarcoma (Tumor B-P 2115)  $\times 260$ .  
 Fig. 6. Osteosarcoma (Tumor B-P 1847)  $\times 137.5$ .  
 Fig. 7. Osteosarcoma (Tumor B-P 2243)  $\times 137.5$ .  
 Fig. 8. Osteosarcoma (Tumor B-P 2294)  $\times 260$ .

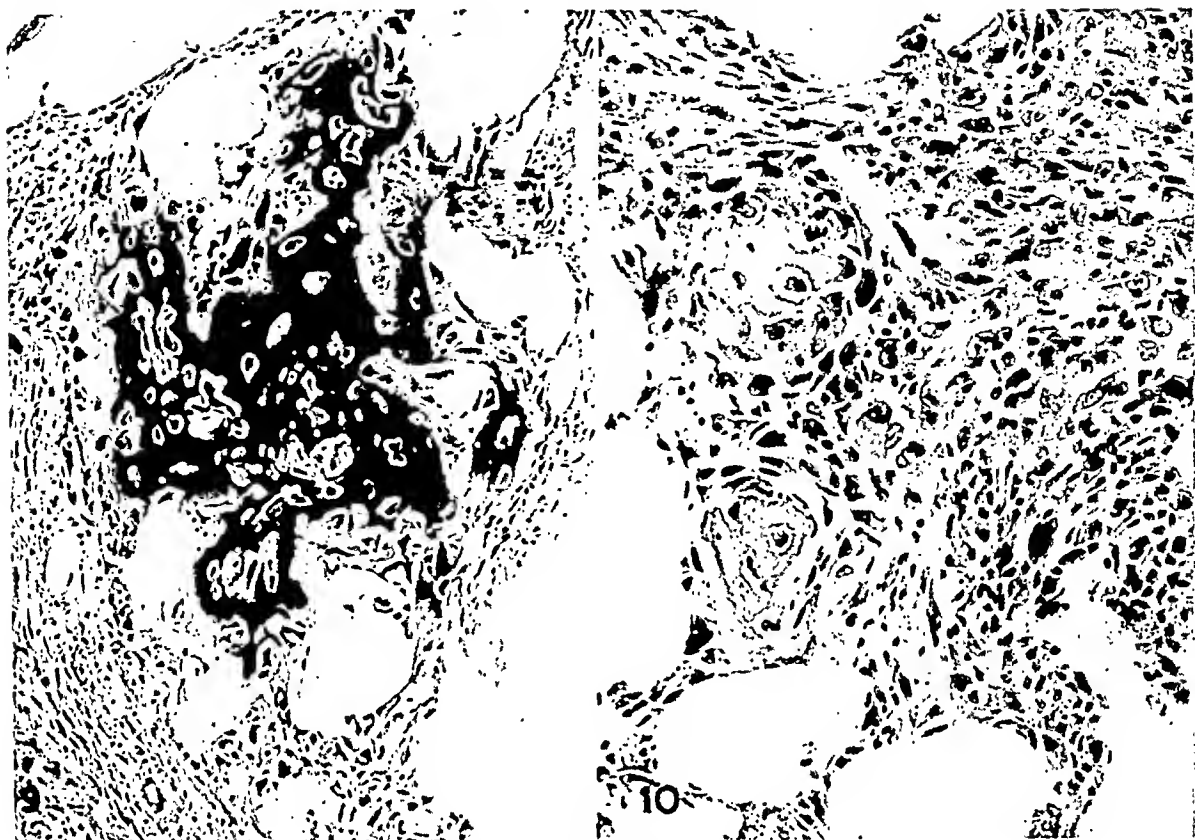


Fig. 9. Early osteosarcoma (Tumor B-P 2717)  $\times 137.5$ .

Fig. 10. Early osteosarcoma (Tumor B-P 2770)  $\times 260$ .

developed in a shorter period than was observed as the mean for a much larger group of induced sarcomata which did not produce bone.

Contrary to observations on human osteogenic sarcomata, these hepatic bone-forming tumors were no more malignant than the non-bone-forming neoplasms of the same series. Thirty-six of the 49 tumor hosts showed a generalized peritoneal dissemination of the tumor, and in only 11 was bone or cartilage demonstrable in the metastases examined. Thirteen or 27 per cent had no gross metastases. In a previously reported series (11) of 3,677 *Cysticercus*-induced tumors, 27 per cent were found to have no demonstrable metastases. In a study of human osteogenic sarcomata, MacDonald and Budd (12) found osteosarcomata more malignant than chondrosarcomata, and fibrosarcomata distinctly less malignant. In this group of liver tumors, 26 were primarily fibrosar-

comata, 10 chondrosarcomata, and 11 osteosarcomata. Twenty, or approximately 80 per cent of the first group, had peritoneal metastases, and in 7 of these bone was demonstrable. Eight of each of the other two classes had generalized secondary growths; cartilage was present in the metastases of 3 of the bearers of chondrosarcomata and bone was found in the peritoneal metastases of only one of the bearers of osteosarcomata. That is, the differences in morphology were not reflected in the relative malignancy of these neoplasms.

#### BENZPYRENE-INDUCED NEOPLASMS

In a series of 2,351 neoplasms induced in rats by the subcutaneous injection of paraffin containing 3:4-benzpyrene, 66 or nearly 3 per cent were osteosarcomata, chondrosarcomata, or fibrosarcomata containing areas of cartilage, osteoid tissue, or bone. Two of these osteoid sarcomata

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TABLE II. CLASSIFICATION OF THE TUMORS INDUCED BY 1 PER CENT BENZPYRENE IN EACH STRAIN OF RATS AND THE PERCENTAGE IN MALES AND FEMALES

Classification	Strain							Total	Per Cent	
	August	Fischer	Marshall	A × C	Sherman	Misc.	Hybrid		Male	Female
Spindle-cell sarcoma and fibrosarcoma	145	79	282	469	151	51	320	1,500	75.46	78.55
Rhabdomyosarcoma	5	2	...	2	9	...	4	22	0.65	1.72
Sarcoma, myogenic?	33	21	35	87	82	5	68	331	19.44	13.88
Fibroma	...	1	2	8	1	...	...	6	0.46	0.11
Liposarcoma	3	...	7	8	...	...	...	18	0.83	1.03
Bone-forming sarcoma	...	1	...	2	1	...	...	24	1.30	1.14
Adenocarcinoma	1	...	...	7	...	...	...	3	0.09	0.23
Squamous-cell carcinoma	...	1	...	...	...	...	...	15	0	1.72
Adenocarcinoma and sarcoma	...	...	...	...	...	...	...	3	0	0.34
Squamous-cell carcinoma and sarcoma	1	...	...	1	...	...	...	1	0.09	0
Endothelioma	...	...	...	4	4	...	...	6	0.28	0.34
Myxosarcoma	4	3	...	...	...	...	...	17	1.11	0.57
Neurosarcoma	1	...	1	...	1	...	...	1	0.09	...
Adenoma	...	...	...	...	...	...	...	3	0.09	0.23
Lipoma	...	...	...	...	...	...	...	2	0.09	0.11
Sum	194	108	336	596	249	58	411	1,952	1,080	872
Early sarcoma	9	12	27	76	17	1	58	200	103	97
Unclassified	5	6	30	38	6	3	13	101	51	50
TOTAL	208	126	393	710	272	62	482	2,253	1,234	1,019

TABLE III. CLASSIFICATION OF THE TUMORS INDUCED BY 0.25 PER CENT BENZPYRENE IN EACH STRAIN OF RATS AND THE PERCENTAGE IN MALES AND FEMALES

Classification	Strain							Total	Per Cent	
	August	Fischer	Marshall	A × C	Sherman	Misc.	Hybrid		Male	Female
Spindle-cell sarcoma and fibrosarcoma	16	37	29	39	65	17	56	259	87.82	82.74
Rhabdomyosarcoma	...	1	...	...	1	...	...	2	0.61	0.72
Sarcoma, myogenic?	1	4	2	1	...	...	1	10	4.88	1.44
Fibroma	...	...	...	...	...	...	...	1	0.61	...
Liposarcoma	2	1	3	2	3	...	...	21	8.63	...
Bone-forming sarcoma	...	...	1	...	...	...	...	1	0	0.72
Adenocarcinoma	...	1	...	...	...	...	...	1	0	0.72
Endothelioma	...	...	...	...	...	...	...	1	0	1.44
Myxosarcoma	...	...	...	...	...	...	...	2	0.61	3.60
Adenoma	...	...	...	...	...	...	...	6	...	...
Sum	19	45	35	43	74	18	69	303	164	139
Early sarcoma	1	11	6	8	4	2	5	37	18	19
Unclassified	2	2	6	8	8	3	1	30	10	20
TOTAL	22	58	47	59	86	23	75	370	192	178

have been previously reported (13). The morphology of the tumors varied considerably. Only 3 were chondrosarcomata (Fig. 1), and 28 were primarily fibrosarcomata with islands of osteoid tissue (Fig. 2), small areas of bone formation (Fig. 3), or extensive areas of calcification (Fig. 4). The largest group consisted of osteosarcomata, but these differed in relative quantity of bone and extent of calcification

as illustrated in Figures 5-8. That the bone formed an integral part of the neoplasm from its initiation is well demonstrated in the tumors shown in Figures 9 and 10. Both were early sarcomata discovered by microscopic examination of the wax cysts.

These bone-forming neoplasms were observed in rats of both sexes of seven different inbred strains and were induced by

TABLE IV: CLASSIFICATION OF THE TUMORS INDUCED BY 0.10 PER CENT BENZPYRENE IN EACH STRAIN OF RATS AND THE PERCENTAGE IN MALES AND FEMALES

Classification	Strain						Total	Per Cent	
	Copen	Marshall	A × C	Sherman	Misc.	Hybrid		Male	Female
Spindle-cell sarcoma and fibrosarcoma	28	10	2	19	8	4	71	86.80	58.14
Fibroma	1	..	..	..	..	..	1	1.89	0
Bone-forming sarcoma	9	6	1	4	1	..	21	11.32	34.89
Adenocarcinoma	..	1	..	..	1	..	2	...	4.65
Adenoma	..	..	..	1	..	..	1	0	2.33
Sum	38	17	3	24	10	4	96	53	43
Early sarcoma	7	3	1	7	2	..	20	9	11
Unclassified	6	1	2	1	..	1	11	7	4
TOTAL	51	21	6	32	12	5	127	69	58

three concentrations of benzpyrene. Tables II, III, and IV give, respectively, the classification of the tumors induced by 1.0 per cent, 0.25 per cent, and 0.10 per cent benzpyrene. From Table II it appears that 24 or 1.2 per cent of the 1,952 classified neoplasms induced by 1.0 per cent benzpyrene were bone-forming sarcomata and that these peculiar tumors occurred with about equal frequency in males and females of this group. From Table III it appears that 21 or nearly 7 per cent of the 303 classified tumors induced by 0.25 per cent benzpyrene were bone-forming sarcomata. These bone-forming tumors represented about 5 per cent of the neoplasms induced in males and nearly 9 per cent of the tumors induced in females by this concentration of benzpyrene. Further, Table IV shows that among 96 classified tumors induced by 0.1 per cent benzpyrene, 21 or more than 20 per cent were bone-forming sarcomata. These osteosarcomata represented 11 per cent of tumors induced in males and nearly 35 per cent of those induced in females by this concentration of the incitant. The several inbred strains were not equally represented in the three groups, but bone-forming sarcomata were observed with about equal frequency in each of 7 inbred strains and in the hybrids, thus reducing the possibility of an inherited constitutional predisposing factor. The sex differences were more apparent in the smaller groups and are probably biologically insignificant, since they are in the

opposite direction of the difference observed among the *Cysticercus*-induced bone-forming sarcomata in the liver.

That the concentration of the incitant was a factor in determining the morphology of these neoplasms is readily seen by a comparison of Tables II, III, and IV. The reduction in the concentration of the benzpyrene significantly increased the proportion of induced bone-forming sarcomata, while it otherwise limited variation in the histogenesis of the induced neoplasms. Although the two series induced by 0.25 per cent and 0.10 per cent benzpyrene were smaller than the series induced by 1 per cent benzpyrene, the absence in the former of any neoplasms containing squamous epithelium is probably significant. It is interesting, further, to compare the morphology of these benzpyrene-induced tumors with a previously reported (14) series of neoplasms induced in the same manner with 1.0 and 0.5 per cent methylcholanthrene. Among approximately 800 tumors induced by methylcholanthrene, no bone-forming neoplasms were identified, but there were 11 tumors composed, in part at least, of malignant squamous epithelium. Evidently, the somewhat more rapidly effective carcinogen and the more concentrated benzpyrene, which was able to penetrate the fibrous capsule of the wax cyst and initiate local squamous metaplasia of the cells lining the mammary ducts that occasionally terminated in squamous-cell cancer, were less effective in inducing

TABLE V: FOR TUMORS INDUCED WITH 1 PER CENT BENZPYRENE, THE MEAN NUMBER OF DAYS TO OBSERVATION AND DEATH, THE MEAN DIAMETER AT AUTOPSY, AND THE MEAN DAILY INCREASE IN DIAMETER IN MILLIMETERS

Group	No. of Tumors	Mean Days to Observation	Mean Days Observation to Death	Mean Diameter in mm.	Mean Daily Increase in Diameter in mm.
2 mg.	103	194 $\pm$ 6	36 $\pm$ 1.4	33.3 $\pm$ 0.8	0.70 $\pm$ 0.04
4 mg.	29	164 $\pm$ 2	32 $\pm$ 1.1	30.9 $\pm$ 0.7	0.66 $\pm$ 0.02
6 mg.	283	151 $\pm$ 2	36 $\pm$ 1.1	30.0 $\pm$ 0.6	0.66 $\pm$ 0.02
8 mg.	176	143 $\pm$ 2	26 $\pm$ 0.9	29.0 $\pm$ 0.8	0.67 $\pm$ 0.03
10 mg.	153	148 $\pm$ 2	24 $\pm$ 1.2	26.4 $\pm$ 0.8	0.63 $\pm$ 0.03
12 mg.	194	148 $\pm$ 2	21 $\pm$ 0.8	25.7 $\pm$ 0.6	0.67 $\pm$ 0.03
16 mg.	49	117 $\pm$ 2	23 $\pm$ 1.7	26.1 $\pm$ 1.3	0.69 $\pm$ 0.05
24 mg.	77	118 $\pm$ 2	18 $\pm$ 1.1	22.0 $\pm$ 0.7	0.77 $\pm$ 0.05
Total with 1 tumor	219	177 $\pm$ 4	35 $\pm$ 1.0	34.1 $\pm$ 0.6	0.70 $\pm$ 0.03
Total first tumors	369	136 $\pm$ 2	35 $\pm$ 0.7	34.5 $\pm$ 0.5	0.70 $\pm$ 0.02
Subsequent tumors	676	152 $\pm$ 1	21 $\pm$ 0.6	22.5 $\pm$ 0.3	0.62 $\pm$ 0.02
SUM	1,264	152 $\pm$ 1	27 $\pm$ 0.5	28.7 $\pm$ 0.3	0.69 $\pm$ 0.01

TABLE VI: FOR TUMORS INDUCED WITH 0.25 PER CENT BENZPYRENE, THE MEAN NUMBER OF DAYS TO OBSERVATION AND DEATH, THE MEAN DIAMETER AT AUTOPSY, AND THE MEAN DAILY INCREASE IN DIAMETER IN MILLIMETERS

Group	No. of Tumors	Mean Days to Observation	Mean Days Observation to Death	Mean Diameter in mm.	Mean Daily Increase in Diameter in mm.
0.5 mg.	24	267 $\pm$ 13	54 $\pm$ 7.0	35.1 $\pm$ 2.0	0.57 $\pm$ 0.05
1.0 mg.	44	245 $\pm$ 11	42 $\pm$ 3.1	30.4 $\pm$ 1.8	0.48 $\pm$ 0.05
1.5 mg.	71	268 $\pm$ 9	45 $\pm$ 2.6	34.6 $\pm$ 1.4	0.58 $\pm$ 0.04
2.0 mg.	74	251 $\pm$ 7	46 $\pm$ 2.7	32.9 $\pm$ 1.5	0.55 $\pm$ 0.04
2.5 mg.	59	242 $\pm$ 9	48 $\pm$ 3.6	31.6 $\pm$ 1.5	0.45 $\pm$ 0.04
3.0 mg.	98	271 $\pm$ 7	40 $\pm$ 2.2	28.3 $\pm$ 1.2	0.51 $\pm$ 0.03
Total with 1 tumor	125	228 $\pm$ 7	44 $\pm$ 2.3	35.7 $\pm$ 3.3	0.57 $\pm$ 0.03
Total first tumors	100	248 $\pm$ 6	53 $\pm$ 1.8	34.5 $\pm$ 1.8	0.51 $\pm$ 0.03
Subsequent tumors	145	293 $\pm$ 5	33 $\pm$ 2.1	20.7 $\pm$ 1.2	0.47 $\pm$ 0.04
SUM	370	259 $\pm$ 4	45 $\pm$ 1.3	28.3 $\pm$ 1.2	0.52 $\pm$ 0.02

TABLE VII: FOR TUMORS INDUCED BY 0.1 PER CENT BENZPYRENE, THE MEAN NUMBER OF DAYS TO OBSERVATION AND DEATH, THE MEAN DIAMETER AT AUTOPSY, AND THE MEAN DAILY INCREASE IN DIAMETER IN MILLIMETERS

Group	No. of Tumors	Mean Days to Observation	Mean Days Observation to Death	Mean Diameter in mm.	Mean Daily Increase in Diameter in mm.
0.2 mg.	7	294 $\pm$ 34	29 $\pm$ 7.8	29.5 $\pm$ 4.4	0.41 $\pm$ 0.11
0.4 mg.	13	301 $\pm$ 29	62 $\pm$ 14.0	27.5 $\pm$ 2.5	0.59 $\pm$ 0.14
0.6 mg.	24	344 $\pm$ 14	34 $\pm$ 3.1	30.4 $\pm$ 2.2	0.42 $\pm$ 0.07
0.8 mg.	26	285 $\pm$ 15	40 $\pm$ 4.1	35.0 $\pm$ 2.5	0.49 $\pm$ 0.08
1.0 mg.	24	290 $\pm$ 15	50 $\pm$ 5.1	34.5 $\pm$ 2.6	0.58 $\pm$ 0.06
1.2 mg.	33	323 $\pm$ 15	43 $\pm$ 6.1	27.5 $\pm$ 2.4	0.43 $\pm$ 0.07
Total with 1 tumor	48	301 $\pm$ 14	43 $\pm$ 4.0	30.9 $\pm$ 1.8	0.51 $\pm$ 0.05
Total first tumors	32	295 $\pm$ 13	47 $\pm$ 4.0	33.4 $\pm$ 1.6	0.45 $\pm$ 0.05
Subsequent tumors	47	342 $\pm$ 10	30 $\pm$ 5.0	28.5 $\pm$ 3.2	0.50 $\pm$ 0.10
SUM	127	315 $\pm$ 7	45 $\pm$ 3.0	31.6 $\pm$ 1.1	0.48 $\pm$ 0.03

bone-forming sarcomata than the dilute benzpyrene.

Further, it appears from Tables V, VI, and VII that the concentration of the localized incitant affected the rate of growth or malignancy of the induced neoplasms. Tumors induced by 1.0 per cent benzpyrene

had an average increase in diameter of  $0.69 \pm 0.01$  mm. per day, while the average daily increase in diameter of the tumors induced by 0.25 per cent and 0.10 per cent benzpyrene was, respectively,  $0.52 \pm 0.02$  and  $0.48 \pm 0.03$  mm. At autopsy the tumors in the three groups were



of nearly equal average diameter, *i.e.*, 30 mm. The rats with tumors induced by 1.0 per cent benzpyrene lived an average of about thirty days after the tumors were observed, while the bearers of tumors induced by the more dilute benzpyrene lived an average of forty-five days. There ap-

pear to be no significant differences which can be attributed to the total dose or number of foci of irritation in the host or to whether the induced neoplasm was the first of multiple tumors, a subsequently observed neoplasm, or the only tumor induced in the host. For each dose and each

class of tumor the average rate of growth was consistently higher for the neoplasms induced by the strongest concentration of benzpyrene.

When the bone-forming neoplasms were similarly tabulated, as shown in Table VIII, it appears that the 24 which were

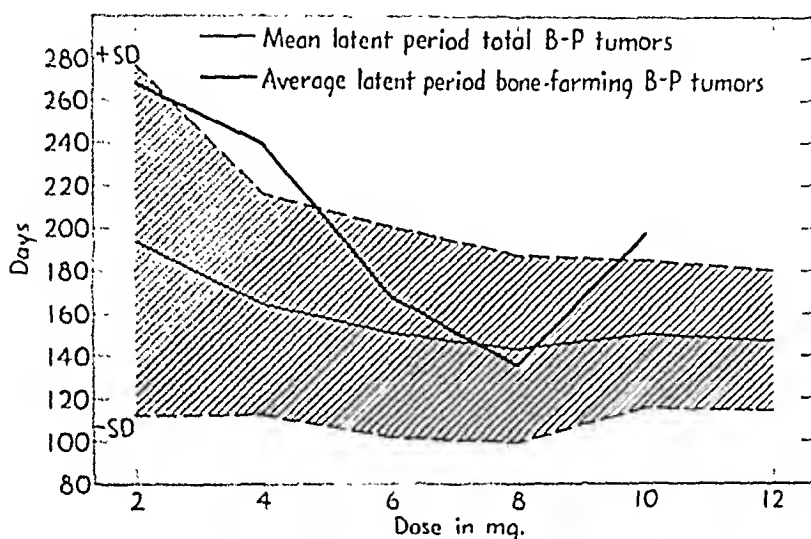


Chart 2. The mean  $\pm$  S. D. latent period for tumors induced by 1 per cent benzpyrene and the average latent period of the bone-forming sarcomata.

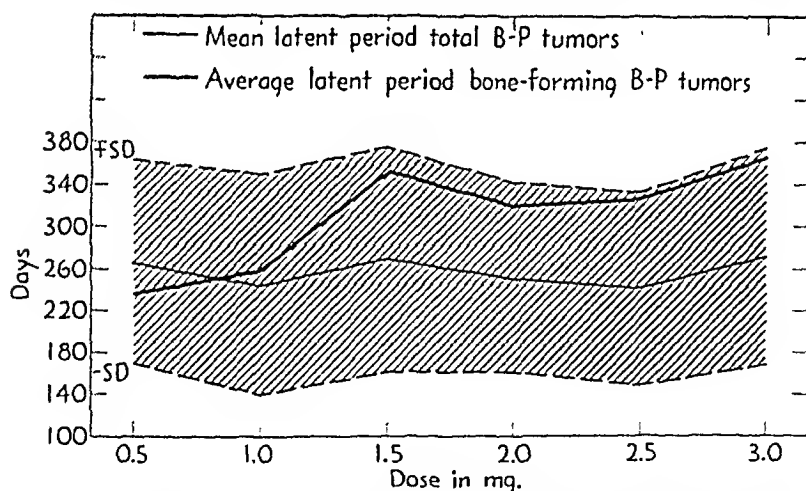


Chart 3. The mean  $\pm$  S. D. latent period of tumors induced by 0.25 per cent benzpyrene and the average latent period of the bone-forming sarcomata.

induced by the 1.0 per cent benzpyrene had a longer average latent period, longer average period from observation to autopsy, and a smaller average daily increase in diameter than the average of the non-bone-forming neoplasms of the series. That is, the bone-forming tumors in this

induced by the 1.0 per cent benzpyrene had a longer average latent period, longer average period from observation to autopsy, and a smaller average daily increase in diameter than the average of the non-bone-forming neoplasms of the series. That is, the bone-forming tumors in this



TABLE VIII: FOR THE BONE-FORMING NEOPLASMS, THE AVERAGE DAYS TO OBSERVATION AND DEATH, THE AVERAGE DIAMETER AT AUTOPSY, AND THE AVERAGE DAILY INCREASE IN DIAMETER IN MILLIMETERS

Group	No. of Tumors	Average Days to Observation	Average Days Observation to Death	Average Diameter in mm.	Average Daily Increase in Diameter in mm.
1 per cent					
2.0 mg.	9	268	46	36	0.49
4.0 mg.	5	239	24	36	0.55
6.0 mg.	8	168	50	32	0.31
8.0 mg.	1	136	34	16	0.20
10.0 mg.	1	197	7	16	0.40
SUM	24	220	41	32	0.41
0.25 per cent					
0.5 mg.	1	238	23	24	0.64
1.0 mg.	3	257	32	..	..
1.5 mg.	5	355	42	35	0.66
2.0 mg.	5	319	75	36	0.38
2.5 mg.	4	325	57	34	0.47
3.0 mg.	3	367	79	22	0.11
SUM	21	323	64	32	0.53
0.10 per cent					
0.4 mg.	1	304	..	..	..
0.6 mg.	9	384	24	17	0.39
0.8 mg.	3	340	84	30	0.43
1.0 mg.	3	223	56	25	0.68
1.2 mg.	5	293	37	14	..
SUM	21	329	52	22	0.46

series were more characteristic of the tumors induced by the weaker concentrations of benzpyrene. Charts 2 and 3 compare the average latent periods of the bone-forming tumors induced by 1.0 per cent and 0.25 per cent benzpyrene, respectively, with the mean latent period  $\pm$  the standard deviation of the total tumors induced by the same concentrations of benzpyrene. Except for one tumor induced in a rat receiving 8 mg. of benzpyrene and one induced by 0.5 mg. of benzpyrene, the average latent period of the bone-forming neoplasms of both series exceeded the mean observed for the series as a whole. Since the average latent period is determined by the dose of the carcinogen and the bone-forming tumors occurred most characteristically with dilute concentrations of benzpyrene, it may be postulated that the few which were observed with the higher concentration of benzpyrene may have resulted from individual foci in some manner depleted of the active agent.

Table IX shows the classification and rate of growth of the bone-forming neoplasms induced by each of the three concentrations of benzpyrene. The tumors are arranged in the order of malignancy re-

ported by MacDonald and Budd (12) for human osteogenic sarcoma. Since the tumors induced by 1.0 per cent benzpyrene tended to be more malignant as a group than those induced by the weaker concentrations of the incitant, it is surprising to find that the proportion of osteosarcomata was higher among the tumors induced by the two weaker concentrations of benzpyrene, and chondrosarcomata, which MacDonald and Budd found to be intermediate in malignancy, occurred only among the tumors induced by the highest concentration of benzpyrene. However, the bone-forming tumors which were primarily fibrosarcoma tended to be less malignant than the osteosarcomata. The average daily increases in diameter of the former were 0.39, 0.34, and 0.28 mm., while for the osteosarcomata induced by the three concentrations of benzpyrene the corresponding figures were 0.50, 0.64, and 0.57 mm. Even though these averages were based on a very few cases of induced heteroplastic bone-forming neoplasms in the rat, they agree with the observations of MacDonald and Budd on the rate of growth of human osteogenic sarcomata.

TABLE IX: NUMBER OF BONE-FORMING TUMORS OF EACH CLASS, THE NUMBER (IN PARENTHESES) WHICH WERE CHARTED, AND THE AVERAGE DAILY INCREASE IN DIAMETER IN MILLIMETERS OF THE CHARTED TUMORS

Classification	1 Per Cent		0.25 Per Cent		0.10 Per Cent	
	No. of Tumors	Ave. Daily Increase in Diameter in mm.	No of Tumors	Ave. Daily Increase in Diameter in mm.	No. of Tumors	Ave. Daily Increase in Diameter in mm.
Fibrosarcoma	15 (11)	0.39	5 (4)	0.34	8 (2)	0.28
Chondrosarcoma	3 (3)	0.33	0	..	0	..
Osteosarcoma	6 (4)	0.50	16 (7)	0.64	13 (3)	0.57
Total	24 (18)	0.41	21 (11)	0.53	21 (5)	0.46

## SUMMARY

1. Among 7,500 neoplasms induced in the rat's liver by *Cysticercus fasciolaris*, 49 were bone-forming tumors. Six of these have been previously reported.

2. These rare bone-forming tumors were fortuitously distributed in the several lobes of the liver, in five different inbred strains of rats, and varied, like the non-bone-forming neoplasms of the series, from benign to highly malignant growths. The hosts had from 1 to 64 parasitic cysts and the latent period was extremely variable.

3. Sixty-six bone-forming neoplasms were observed in a series of 2,351 tumors induced in rats by the subcutaneous injection of paraffin containing 3:4-benzpyrene. These neoplasms occurred in rats of both sexes of seven different inbred strains.

4. The bone-forming neoplasms were induced by three concentrations of benzpyrene, namely, 1.0 per cent, 0.25 per cent, and 0.10 per cent, and comprised 1.0 per cent, 7.0 per cent, and 20.0 per cent of the tumors induced by these respective concentrations of the incitant.

5. The concentration of the incitant affected the rate of growth and malignancy of the induced neoplasms. Tumors induced by 1.0 per cent benzpyrene had a shorter latent period, a greater average daily increase in diameter, and killed the host in a shorter average interval after observation than the tumors which were induced by weaker concentrations of benzpyrene.

6. The bone-forming neoplasms induced by 1.0 per cent benzpyrene had a longer average latent period, longer av-

erage period from observation to death, and a smaller average daily increase in diameter than the average of the series. In these characters, they resembled the tumors induced by the weaker concentrations of benzpyrene.

7. The most favorable incitant of heteroplastic bone-forming neoplasms was 0.10 per cent benzpyrene in paraffin, the weakest concentration of incitant thus far tested.

8. The osteosarcomata had a greater average daily increase in diameter than the bone-containing neoplasms, which were primarily fibrosarcomata.

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## CASE REPORTS

### So-Called "Subperiosteal Giant-Cell Tumor"<sup>1</sup>

MAJ. ARTHUR J. PRESENT, M.C., A.U.S.

Very few so-called subperiosteal giant-cell tumors have been reported, and an interesting diagnostic problem is offered when one is seen radiographically. Geschickter and Copeland (1) reported but four such cases in their series and noted that all had been published since January 1926. They point out the characteristic history of trauma and the short duration of symptoms. These features were noted, also, in the cases of Cone (2) and Potts (3).

The striking microscopic observation of multinucleated giant cells and the osteogenic response of the periosteum has given the name of subperiosteal giant-cell tumor to this condition, which histologically bears a close resemblance to giant-cell tumor of bone. It is believed by MacCallum (4), Cone (2), and Geschickter and Copeland (1), to be a reparative process, a process modified by the cells and the mechanical factors present beneath the periosteum.

Radiographically a more or less completely encapsulated mass is seen, elevating the periosteum and excavating the adjacent cortical bone. No bone proliferation is apparent and there is no true medullary involvement. The latter condition may be suggested, however, by decreased density over the areas of eroded cortical bone.

A 33-year-old soldier was admitted to the Hoff General Hospital on Aug. 31, 1943, complaining of pain in the left forearm of two months' duration. Discomfort had been noticed a few hours after scuffling in company football, and there had been early mild swelling just below the elbow posteriorly. These symptoms were aggravated by use and at first varied in intensity. Subsequently, the pain became sharp and more persistent, and the swelling increased slowly. On Aug. 28 the patient presented himself for treatment at his station hospital, whence he was transferred to Hoff General Hospital with a diagnosis of "osteogenic sarcoma."

Physical examination on admission revealed a



Fig. 1. Subperiosteal giant-cell tumor of radius.

firm, circumscribed fusiform swelling on the dorsal aspect of the left radius at the junction of its proximal and middle thirds. Complete function was present except that supination was limited somewhat by pain. Tenderness was elicited on palpation.

Roentgenograms revealed a well circumscribed, faintly calcified mass 5 cm. distal to the articular surface of the radial head (Fig. 1). It extended for 5 cm. along the shaft of the radius and was 2 cm. in width. Beneath it the cortical bone showed a saucer-like excavation, and the medullary bone contained several areas of apparent diminished density. The margins of the elevated periosteum or tumor were rounded and lacked the "triangle" so frequently seen in malignant neoplasms. The findings were interpreted as follows: "A benign tumor with subperiosteal hematoma as the most probable diagnosis. A malignant tumor cannot be entirely excluded."

Under an upper arm tourniquet the area of the mass on the dorsum of the left forearm was opened on Sept. 8, 1943, by Major Robert F. Warren, M.C. The tumor was found to be bluish-gray, about 5 cm. long and 4 cm. wide, and enclosed by an edematous capsule. Aspiration of 3 c.c. of bloody fluid by

<sup>1</sup> Accepted for publication in June 1944.

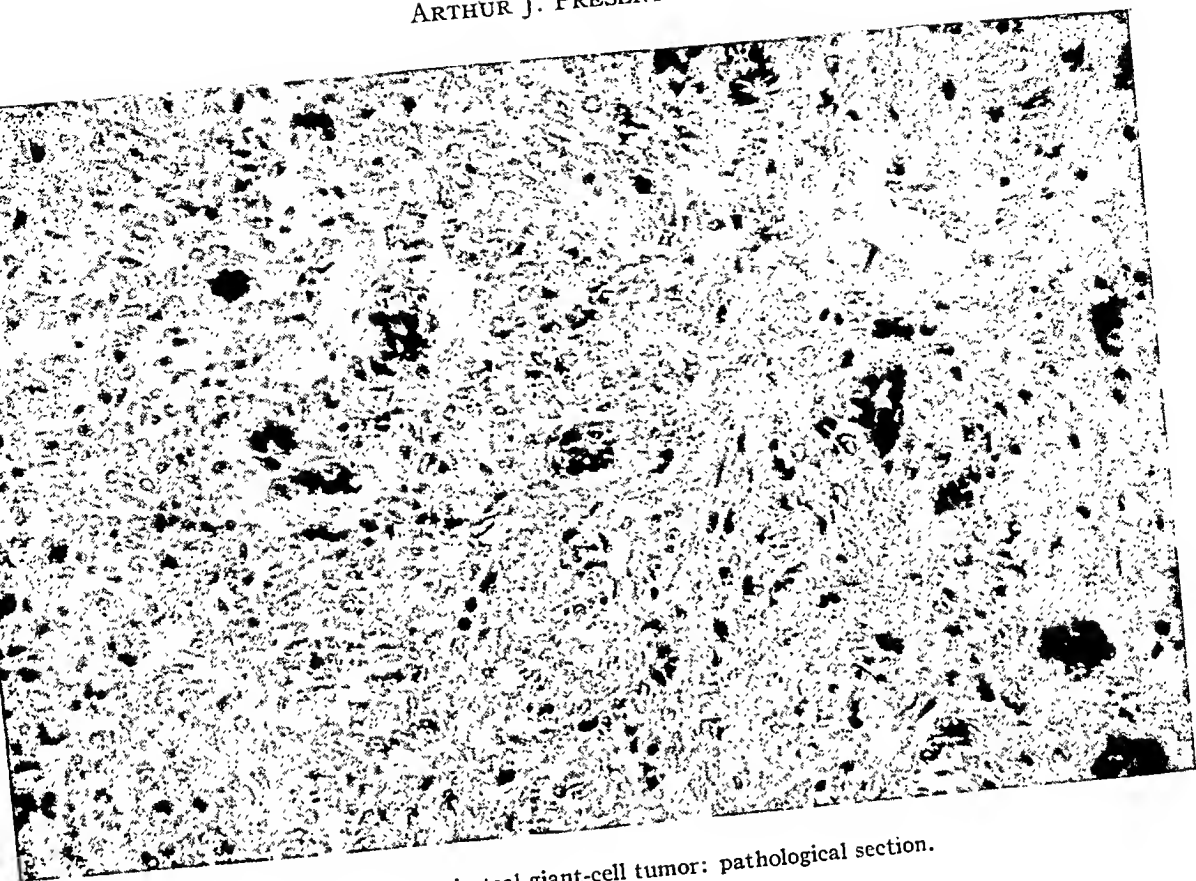


Fig. 2. Subperiosteal giant-cell tumor: pathological section.

needle caused the mass to collapse. The wall was then opened and was seen to be about 3 mm. thick. Just beneath it were many minute (1 mm.) nodules of cellular tissue, several of which were removed. On examining the cortex, an area of erosion 1 cm. in length and 3 mm. wide was found, which was filled by a mass of red, fleshy material. This was removed for frozen section. Thereafter the entire area of elevated periosteum was excised and the cortical bone rongeuired away about the fissure. The wound healed promptly and the patient was discharged to duty.

Captain Cecil F. Baisinger, M.C., studied the tissue specimens. They were red, moderately firm, and grossly suggested granulation tissue. Some fine calcification could be readily identified. On the frozen sections a fibrous appearing osteoid tissue was seen, in which there were many large multinucleated giant cells with centrally placed nuclei (Fig. 2). This finding was confirmed by the paraffin sections, which showed the stroma to be cellular, the cells being mostly large, vesicular, and pale-staining, with poorly defined cytoplasm. Other cells were present, which were smaller, more dense, and with distinct nucleoli. In this stroma were many typical multinucleated giant cells, most of which had over fifteen nuclei. In addition there were many macrophages loaded with yellowish-brown granular pigment, and some recent hemorrhage was present. Areas of osteoid tissue were found which were acidophilic and

much less cellular. Sections of decalcified bone showed erosion, with osteoclasts in apposition to the outer surfaces. Definite new bone formation was apparent in some areas. Pathological diagnosis: "Subperiosteal giant-cell tumor of the radius."

The findings in this case are typical of those ascribed to subperiosteal giant-cell tumor. The radiographic impression of a subperiosteal hemorrhage is not surprising, since there was a completely encapsulated, lightly calcified tumor which appeared to displace the periosteum. The benign nature of the condition was suggested by the complete capsule and the absence of new bone formation. The patchy areas of diminished density in the medullary portion of the bone with the erosion of the cortex, however, made it impossible to feel secure in this conclusion. A biopsy, under such circumstances, seemed indicated.

#### CONCLUSION

A case of so-called "subperiosteal giant-cell tumor" of the radius is reported in detail.

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## Klippel-Feil Malformation: Report of a Case in an Adult

MAJ. WILLIAM E. ALLEN, JR., M.C., A.U.S.

According to Dyke (2) the so-called Klippel-Feil malformation of the cervical region of the spine was first described by Willett and Walsham in 1880. Other writers (1, 5, 6) disagree, attributing the first description to Klippel and Feil in 1912. In 1919 Feil compiled all the reported cases and published them in the form of a thesis (3, 6).

Congenital anomalies of the cervical spine were once considered uncommon (1, 3, 4), but in recent years they have been repeatedly described and are probably even more frequent than the case reports would indicate. In 1932, only 30 cases of the Klippel-Feil syndrome had been reported, chiefly in the French literature; 3 cases had been reported in America and 1 in England (1). In 1934 Willard and Nicholson (6) were able to collect 60 cases from the literature. A number of additional reports have appeared since that time.

The anomaly is characterized clinically by an absence or shortening of the neck, lowering of the hair line on the back of the neck, and limitation of motion, especially lateral bending, of the neck. Flexion, extension, and rotary movements are usually normal (5). All or most of the bodies of the cervical vertebrae may be fused (1, 2, 4, 6). The number of the cervical vertebrae may be diminished, the spinous processes may be fused, and often there is an irregular formation of the lateral masses

and bodies. The arches of the vertebrae may fail to unite posteriorly, resulting in a spina bifida occulta. Often there are associated malformations of the ribs, such as cervical ribs, crowding of the ribs, fusion of the ribs, as well as congenital anomalies in other parts of the body. Fusion of the scapula with the cervical vertebrae may occur (2). Willard and Nicholson (6) give the following specific additional variations, which have been noted in reported cases: fusion of the atlas to the occiput; fusion of the first three vertebral bodies with fusion of the spines of the third, fourth, and fifth cervical vertebrae; fusion of the first and second cervical vertebrae with the third intact and the fourth, fifth, and sixth fused; fusion of the third, fourth, fifth, and sixth cervical bodies and fusion of the sixth and seventh cervical and first and second dorsal spinous processes; reduction to four cervical vertebrae; all cervical vertebrae fused in one mass with four cervical ribs and reduction of the dorsal vertebrae to eight; a posterior spina bifida occulta which may extend from occiput to thorax; fusion of the six upper dorsal vertebrae; fusion of first and second right ribs and two ribs arising from fourth dorsal vertebrae on the left, fusion of the fifth lumbar vertebra and the sacrum; dorsal spina bifida occulta and sacral rachischisis; oblique bodies of the cervical and dorsal vertebrae with a hemivertebra and unfused lamina. From this enumeration the wide range of variation is obvious.

The etiology of the malformation is uncertain, but all writers agree that, whatever the changes may be, they take place within the uterus, early in fetal development. Trauma (3, 6), arrest in development (4), intrauterine inflammation (3), irregular segmentation of the spine occurring in the early weeks of fetal life, and morbid conditions interfering with normal development of the fetus (1) have been given as causes. In 1919 Feil expressed the belief that a high spina bifida is the original lesion and that pressure and trauma later in fetal life cause the fusion and malformation (6).



Fig. 1. Photographs of patient showing short neck and small lipoma in right scapular region, asymmetry of suprascapular regions due to elevation of right scapula, and low hair line.



Fig. 2. Lateral roentgenogram of cervical spine showing deformities of bodies and spinous processes.

The lesion is most commonly confused with tuberculosis of the cervical spine, but can be differentiated from that disease by the absence of rigidity, motion without pain, and the roentgen findings. It may be associated with unilateral edema of the upper extremity, mirror movement or synkinesia, muscle spasm, constant contrac-

tion of the cervical muscles, high scapula (Sprengel's deformity), deformities of the shoulder and bones of the upper extremity, torticollis, facial asymmetry, dorsal scoliosis, difficulty in breathing or swallowing, shortness of breath, nystagmus, lesions of the brachial plexus, spastic paraplegia, sphincteric disturbances, neurotrophic joints, absence of the external auditory meatus, deafness, kyphosis, and mental deficiency.

There is no treatment for the deformity itself (1), although Willard and Nicholson (6) quote Heidecker as claiming improvement in mobility after gymnastic exercise. The condition, while most frequently found in children, is not incompatible with longevity, having been observed in a patient of seventy years (3).

#### CASE REPORT

A colored soldier, age 24, a native of North Carolina with seven months' Army service, was seen in the Orthopedic Out Patient Clinic of Station Hospital No. 1, Ft. Huachuca, Ariz., on June 23, 1943, complaining of a small tumor on his right shoulder, which caused him some difficulty in carrying his pack. He was sent to the X-Ray Department for an examination, which revealed elevation of the scapula and a malformation of the upper ribs and dorsal spine. The patient was admitted to the hospital for further study on June 30. His chief com-





Fig. 3. Roentgenogram of thorax showing malformation of upper dorsal vertebrae and ribs.



Fig. 4. Roentgenogram showing malformation of lower cervical and upper dorsal vertebrae and ribs.

plaint was still the small mass on his right shoulder. He gave a history of measles and malaria as a child and an injury to his right shoulder at the age of nine. He had had no tropical service, admitted the use of tobacco but denied the use of alcohol. There was no familial history of chronic or degenerative disease. His father, mother, four sisters, and four brothers were living and well. None showed any deformity.

The patient was intelligent and mentally alert and was anxious to get back to his company. His neck was thick and short and his hair line low. He could not move his neck laterally in either direction, but limited flexion, extension, and rotary motion were possible. There was a kyphosis of the upper dorsal spine. The right scapula was elevated, and there was a soft, freely movable soft-tissue mass, 6 cm. in diameter, just above the medial angle of the right scapula. No other evidence of disease, deformity, or congenital anomaly was noted. There was no evidence of synkinesia.

Roentgen examination of the thorax and spine revealed the following anomalies: (1) elevation of the right scapula; (2) fusion of the first cervical vertebra to the occiput; (3) fusion of the bodies of the second and third cervical vertebrae; (4) fusion of the spinous processes of the second and third cervical vertebrae; (5) narrowing of the body of the fourth cervical vertebra; (6) spina bifida occulta of the fourth cervical vertebra; (7) spina bifida occulta of the seventh cervical vertebra; (8) bifid spinous process of the fifth cervical vertebra; (9) partial fusion of the bodies of the seventh cervical and first dorsal vertebrae on the left side; (10) dorsal hemivertebrae; (11) deformed bodies of the upper dorsal vertebrae; (12) kyphosis of the upper dorsal spine; (13) right scoliosis of the dorsal spine; (14)

right cervical rib; (15) fusion of the first and second ribs on the right at their vertebral articulation; (16) fenestration of the second rib on the right in the posterior axillary line; (17) a rudimentary right twelfth rib; (18) narrowing of the intercostal spaces in the left mid thorax; (19) thinning of the left fifth rib posteriorly.

#### SUMMARY

A case of malformation of the upper spine and thorax in a soldier who had engaged in strenuous infantry field training for seven months without symptoms is reported.

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# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

## Lewis George Allen, M.D

In the choice of Lewis George Allen as President, the Radiological Society of North America has been fortunate. During the years of his membership Doctor Allen has demonstrated his willingness to assume responsibility and his ability to work diligently and with originality in the discharge of his duties. His was the task of formulating the plans and executing the details of the first Refresher Series presented by the Radiological Society, an undertaking which those who have had the opportunity of working with him know to have been an exacting one.

Born in Lenexa, Kansas, Doctor Allen was graduated from the University of Kansas School of Medicine. He served an internship at St. Joseph's Hospital, Kansas City, Mo., and at the Royal Victoria Hospital, Montreal, Canada, the latter being interrupted by his entrance into the United States Army in World War I. Assigned to the Kansas City School of Military Roentgenology, he was with the A. E. F. as a member of Base Hospital 116 and Mobile Hospital No. 9.

Following the war, Doctor Allen entered upon the private practice of radiology in Kansas City, Kans. He is radiologist to Bethany Hospital, Providence Hospital, and St. Margaret's Hospital, in that city, and is Professor of Clinical Roentgenology in the University of Kansas School of Medicine.

Doctor Allen has not limited his activities to radiology but has taken a lively interest in organized medicine. He is a Fellow of the American College of Physi-

cians, has for many years been active in the affairs of the Kansas Medical Society, and has served as President of the Wyandotte County Medical Society and as President of the Kansas City Southwest Clinical Society. He is an honorary member of the Kansas City Academy of Medicine and active in various committees of the Medical School.

His interest in radiology has made him an energetic participant in local and national radiologic organizations. He was a member of the first class certified by the American Board of Radiology. He is a Chancellor of the American College of Radiology and Chairman of its Commission on Public Relations. He is Past-President of the Kansas Radiological Society and a member of the American Roentgen Ray Society.

Civic affairs have claimed Doctor Allen's attention to the end that he is now Chief of Emergency Medical Service under the Civilian Defense program for Kansas City, Kans., as well as participating in the Kiwanis Club, of which he is a charter member. He is a trustee of Group Hospital Service, Inc., and Surgical Care, Inc.

Doctor Allen has contributed numerous articles to the literature of radiology and has taken an active part in the programs of the medical organizations of which he is a member.

The demand for relaxation from such a busy routine is satisfied by motion picture photography and the operation of a small farm near Kansas City.

IRA H. LOCKWOOD, M.D.



LEWIS G. ALLEN, M.D.  
President of the Radiological Society of North America

## A Trade Journal Looks at Medicine

The August 1944 issue of the *Railroad Journal*<sup>1</sup> is designated "American Health Number." This remarkable issue of a trade journal should be read by all physicians interested in medical practice. We say "remarkable" because, for the first time, to our knowledge, a monthly magazine published by and for a large industrial group, devotes an entire issue to an authoritative series of articles on the problem of sickness and sickness insurance.

The tenor of the majority of the articles may be gleaned from the title of the leading editorial and the contents of a "box" at the end of the editorial section. The title of the editorial, by Nathan Smith Davis, III, M.D., of Northwestern University Medical School, is the familiar and pertinent aphorism attributed to Bishop Creighton of London: "No people do so much harm as those who go about doing good." To this group, in the United States, Dr. Davis attributes such projects as the National Health Program, the Report of the National Resources Planning Board, and the Wagner-Murray-Dingell Bill. The box at the end of the editorial section reads as follows:

<sup>1</sup> Available from Mr. Alex Brandau, Public Relations Director, The Railroad Journal, 65 East Harrison St., Chicago, Ill.

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### Message to Employers

The sole purpose of this issue is to bring to you the story of the efforts and accomplishments of American Doctors and Hospitals—and to suggest that you give serious thought to the protection of yourself and your employees through the establishment of insurance programs similar to the ones described in this issue.

**If You Don't Do It, the Government Will—at Higher Cost**

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The contributors to the issue include Victor G. Heiser, John R. Mannix, Louis H. Pink, Edward H. Skinner, Morris Fishbein, and numerous other well known writers on the subject of medical care. Their opinions are expressed concisely, and the volume represents an unusually convenient collection of such points of view. If any suggestion could be made for future issues of this type, it would be to include more data on *all* of the various State Medical Society sponsored plans, and to list the addresses in order that interested executives and others would know exactly where to go for information.

L. H. GARLAND  
*Lt. Comdr. (MC) USNR*

## ANNOUNCEMENTS AND BOOK REVIEWS

### NEBRASKA RADIOLOGICAL SOCIETY

At the meeting of the Nebraska Radiological Society held Nov. 15, the following officers were elected: F. L. Simonds, M.D., Omaha, President; Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5, Secretary-Treasurer.

### VIRGINIA RADIOLOGICAL SOCIETY

The newly elected officers of the Virginia Radiological Society are: Clayton W. Eley, M.D., Norfolk, President; W. P. Gilmer, M.D., Clifton Forge, Vice-President, and E. L. Flanagan, M.D., Richmond, Secretary.

## Book Reviews

**METASTASES, MEDICAL AND SURGICAL.** BY MALFORD W. THEWLIS, M.D., Attending Specialist in General Medicine, United States Public Health Hospitals, New York City; Attending Physician, South County Hospital, Wakefield, Rhode Island; Special Consultant, Rhode Island Department Public Health; Author *Care of the Aged* (Geriatrics), *Preclinical Medicine*. Foreword by HUBERT A. ROYSTER, A.B., M.D., F.A.C.S., Honorary Chief of Surgical Service, Rex Hospital; Chief-of-Staff, St. Agnes Hospital; Consulting Surgeon, Dix Hill State Hospital, Raleigh; Fellow, American Board of Surgery. A volume of 230 pages, with 13 illustrations. Published by the Charlotte Medical Press, Charlotte, N. C., 1944. Price \$5.00.

The term metastasis, while it is particularly associated with transfer through the blood or lymph stream of malignant cells from a primary focus to some distant site, is equally applicable to the movement of bacteria and to the change of location of diseases of virus origin and those due to protozoa and other parasites. All these phases of the problem are included in Doctor Thewlis's book. The work is essentially a series of outlines, preceded by a brief general introduction. Its object is to provide a ready guide to the probable secondary sites of various disease processes.

The first of the outlines has to do with Neoplasms. Here are listed the numerous types of new growth—from acanthoma to xanthomatosis—with the primary sites and the sites of metastasis given under each, the sites of predilection being italicized. The second and third outlines cover Infections and Infectious Diseases, between which the author makes a distinction. Under the latter head are included actinomycosis, amebiasis, bilharziasis, blastomycosis,

cerebrospinal meningitis, echinococcus cyst, erysipelas, gonorrhea, influenza, leishmaniasis, meningitis, mumps, parasitic diseases (trypanosomiasis, malaria, filariasis), rheumatic fever, *S. suispestifer* infection, syphilis, trichinosis, tuberculosis, tularemia, and typhoid. The fourth of the outlines, headed *Miscellany*, includes a variety of conditions not covered by the other classifications, as the anemias, arthritis, endocarditis, leukemia, etc. The final outline, which covers 100 pages, or almost half the volume, is perhaps the most valuable of all. Here the organs and regions of the body are listed with the primary lesions affecting each, the metastases to which they may give rise, and the metastatic lesions by which each may be involved.

An extensive bibliography is given at the end of the book and an adequate index makes it possible to find quickly either the disease or anatomical area in which one is interested. This feature is particularly useful, as the author's classification of diseases may in some instances be open to question. A number of anatomical drawings showing the lymph drainage areas are reproduced from standard texts.

Mechanically the book suffers somewhat from wartime printing conditions, and it is unfortunate that the errors listed on the insert could not have been caught in the proof. These features, however, do not impair the value of the work for reference. It should appeal especially to the busy practitioner who wishes to refresh his memory as to the routes and sites of metastasis. It will be of value to internists, surgeons, pathologists, and roentgenologists, and, of course, to all students of medicine.

**THE 1944 YEAR BOOK OF RADIOLOGY.** Diagnosis, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor, WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital (on leave with the Armed Forces). Therapeutics, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 448 pages, with 363 illustrations. Published by The Year Book Publishers, Chicago, Ill. Price \$5.00.

This latest addition to the series of Year Books of Radiology follows the general plan of the earlier volumes in its presentation of abstracts of articles appearing in the world's literature during the last year, which is to say from about the middle of 1943 to the middle of 1944. It is a volume of 450 pages.

well printed and bound, and a worthy addition to any medical library.

As the editors point out, the year was a particularly difficult one for such a project. In spite of this, the volume compares favorably with those of past years. The literature—with unavoidable geographical limitations—is well covered, and the abstracts are good, giving the essential content of the articles in fairly full detail. The reproduction of numerous well chosen illustrations adds greatly to the value of the text. Under the two main divisions of Diagnosis and Therapy, the material is classified on an anatomical basis, and a comprehensive index is appended.

The book is interesting and instructive throughout and is especially helpful now, when so much must be done in so little time. It is recommended without qualification.

**THE PRACTICE OF MEDICINE.** BY JONATHAN-CAMPBELL MEAKINS, M.D., LL.D., Brigadier, Deputy Director General of Medical Services, Royal Canadian Army Medical Corps; Professor of Medicine and Director of the Department of Medicine, McGill University; Physician-in-Chief, Royal Victoria Hospital, Montreal; Formerly Professor of Therapeutics and Clinical Medicine, University of Edinburgh; Fellow of the Royal Society of Edinburgh; Fellow of the Royal Society of Canada; Fellow of the Royal College of Physicians, London; Fellow of the Royal College of Physicians, Edinburgh; Honorary Fellow of the Royal College of Surgeons, Edinburgh; Fellow of the Royal College of Physicians, Canada; Fellow of the American College of Physicians; Honorary Fellow of the Royal Society of Medicine. A volume of 1,444 pages, with 517 illustrations, including 48 in color. Published by the C. V. Mosby Co., St. Louis, Mo. Fourth Edition, 1944. Price \$10.00.

The present edition of Meakins's well known *Practice of Medicine* represents a considerable revision over the edition of 1940, new material having been added to keep pace with advances both in civilian practice and in military medicine. The current interests of the author, as Brigadier, Deputy Director General of Medical Services of the Royal Canadian Army Medical Corps, are reflected in the inclusion in a text on internal medicine of such conditions as immersion foot, blast injuries, crush syndrome, and other states which have become more common in wartime. All of the general features of

the previous edition are retained or amplified. The section on the use of the sulfonamides is thoroughly adequate for a general text, and additional consideration of chemotherapy is given under the specific diseases in which it is indicated. Penicillin receives brief mention.

A unique feature is the illustrative material included in this book. Of the 517 illustrations, 186 are reproductions of roentgenograms, well selected for their teaching value. The present-day importance of radiography in diagnosis is well correlated with the clinical picture in diseases of the various systems.

In line with modern thought, added emphasis is placed on functional disturbances and psychosomatic medicine. The importance of prophylaxis over therapy—positive health as opposed to negative health or disease—is stressed.

Each section is followed by an adequate bibliography, and a 50-page index makes the comprehensive contents of this text readily accessible.

**THE URINARY TRACT. A HANDBOOK OF ROENTGEN DIAGNOSIS.** BY H. DABNEY KERR, M.D., Professor of Radiology, State University of Iowa College of Medicine, and CARL L. GILLIES, M.D., Associate Professor of Radiology, State University of Iowa College of Medicine. A volume of 320 pages, with numerous illustrations. Published by The Year Book Publishers, Inc., Chicago. Price \$5.50.

This is the third of a projected six-volume series of handbooks on roentgen diagnosis and follows essentially the form of the preceding volumes. It is actually an atlas containing many illustrations and streamlined clinical and roentgenological text of unusual clarity.

The authors have divided the book into sections on the kidney, ureter, bladder, and urethra. Under each section a fairly uniform pattern is followed. A general description is given of the lesion under consideration, followed by a group of excellent illustrations, each of which is clearly described on the opposite page. These illustrations are unretouched and the reduction is uniform throughout, 37 per cent of actual size. Many helpful hints regarding differential diagnosis are included both in the text and illustrations. A bibliography is appended.

This is an excellent handbook for students and roentgenologists and can be highly recommended. It is concise, lucid, and surprisingly complete for its size.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Douth, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 p.m., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Oehsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 p.m. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.



## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St. Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—Secretary-Treasurer, Asa E. Secds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave. Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—General Secretary, Origène Dufréne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

# ABSTRACTS OF CURRENT LITERATURE

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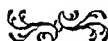
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## THE HEAD AND NECK

**Roentgenological Findings in Bilateral Symmetrical Thinness of the Parietal Bones (Senile Atrophy): Report of a Case with a Review of the Literature.** Angus K. Wilson. *Am. J. Roentgenol.* 51: 685-696, June 1944.

A case of bilateral symmetrical thinness of the parietal bones is presented in detail and a general review of the literature is given with a bibliography of sixty-seven references. It is probable that the condition was known to the ancients, since many examples taken from Egyptian tombs have been described. The first modern description is ascribed to Köhler in 1786. The characteristic location of the thinned areas is between the sagittal suture and the parietal prominence. Characteristically, there is a crest-like ridge of intervening bone centered on the sagittal suture which separates the parietal depressions. Frequently, there is a shallow groove-like depression of the sagittal crest.

Two chief forms have been described: (1) a roughly triangular or quadrilateral flattened depressed area and (2) a trough-like depression running longitudinally along both sides of the sagittal suture. The latter type may extend into the frontal and occipital areas. Pathologically, there is no sharp line of demarcation between the depression and the adjacent normal external tables; the margins shelf gradually into the thinned area. The floor of the depression may be of parchment-like thinness, extremely fragile, and translucent.

Many theories have been advanced in an attempt to explain this thinning of the parietal bones. By the majority of authors it is considered an atrophic change, but explanation as to the cause of the atrophy varies widely. The views of numerous students of the subject are presented.

Roentgen diagnosis of the condition and differentiation from disease processes are based on the finding of (1) a symmetrical bilateral localized involvement with (2) smooth, regular margins, (3) absence of a surrounding zone of new bone formation, (4) lack of evidence of malignant lesions elsewhere in the body, and (5) absence of pain or tenderness. The author was able to find only one other case published in the American literature with roentgenologic findings (Moore: *J. Missouri M. A.* 26: 396, 1929), but in a footnote refers to a recent article by Camp and Nash (*Radiology* 42: 42, 1944) which was published subsequent to the preparation of his paper. L. W. PAUL, M.D.

**New Light on the Origin of Craniolacunias.** J. Blair Hartley and C. W. F. Burnett. *Brit. J. Radiol.* 17: 110-114, April 1944.

A case of partial or circumscribed craniolacunia or lacunar skull with hydrocephalus, in a stillborn fetus, is reported. The skull showed marked lacunar changes in the anterior halves of the cranial bones centrally, while the peripheral and posterior portions and the parietal bones were normal in this respect. The squamous portion of the occipital bone was strikingly expanded.

This case, which is the first of partial or circumscribed craniolacunia to be recorded, is of special interest in relation to the etiology of the condition. The

authors examine the three most commonly held theories in the light of their observations. (1) The theory of a pressure effect due to an internal hydrocephalus would not seem to hold here, in view of the localized character of the changes. (2) While a developmental chromosomal defect might enter into consideration, observations in other cases, indicating that the condition has a tendency to disappear with increasing age, are opposed to this view, since such developmental defects and deformities invariably persist. (3) The third etiologic theory appears more likely, namely that this anomaly results from some hormonal or dietary deficiency during pregnancy. Rats receiving a deficient diet have been shown to produce offspring with congenital skull defects and rib deformities (Warkany and Nelson: *Am. J. Roentgenol.* 47: 889, 1942); craniolacunia is often found in association with other skeletal defects, chiefly in membranous bones; finally, the condition is observed only in children of the poorer classes.

SYDNEY J. HAWLEY, M.D.

**Tuberous Sclerosis.** A. T. Ross and W. W. Dickerson. *Arch. Neurol. & Psychiat.* 50: 233-257, September 1943.

In this rather lengthy article, the various features of the congenital hereditary or familial entity known as tuberous sclerosis are discussed in detail. The basic characteristics of this developmental tissue dysplasia are of ectodermal origin, but defective development and tumor formation are frequently identified elsewhere.

Clinically, the outstanding findings are adenoma sebaceum on the face, retinal tumors, mental deficiency, and convulsions. Neurological changes are usually minimal despite the occurrence of numerous nodular sclerotic areas throughout the central nervous system and viscera.

Roentgenograms of the skull may show multiple small discrete areas of calcification throughout the brain substance, particularly in the region of the sella turcica, the basal ganglia, and the choroid plexuses. Additional round or oval areas of increased density may be found within the calvarium. Pneumoencephalograms usually show some degree of generalized brain atrophy and occasionally yield evidence of the one pathognomonic sign of tuberous sclerosis, *viz.*, intraventricular tumors having the appearance of wax candle gutterings.

Roentgenograms of the hands may show cystic areas of rarefaction in the metacarpals and phalanges, and osteoporosis. Polydactylism also may be present.

DEPARTMENT OF ROENTGENOLOGY  
UNIVERSITY OF MICHIGAN (J. H.)

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the body, and increase in intracranial pressure. Roentgen exposures in the Towne and Stenvers projections showed extensive erosion of the right internal acoustic meatus and the ridge of the right petrous bone. Gradual onset of tinnitus and deafness in the right ear had been observed over a period of six years. Operative removal of the tumor was followed three months later by a spinal accessory-facial nerve anastomosis with excellent clinical results.

DEPARTMENT OF ROENTGENOLOGY  
UNIVERSITY OF MICHIGAN (J. H.)

**Cholesteatoma with Fistula into the Labyrinth. Report of a Case in Which the Roentgenologic Findings Were Confusing.** Hans Von Leden and Henry L. Williams. *Arch. Otolaryng.* 39: 432-433, May 1944.

A 37-year-old woman complained of intermittent discharge from the left ear and dizziness. The discharge had been present for four years and the dizziness for fourteen months. Examination revealed a dry ear with a medium-sized attic fistula. The drum membrane was covered with hard crusts and could not be fully visualized. The right drum membrane was thickened and somewhat retracted but otherwise normal. Tuning fork tests and an audiogram revealed moderate conduction deafness on the left side. There was spontaneous nystagmus on looking to both sides, and the fistula test was mildly positive on the left.

Roentgenographic examination of the mastoid regions revealed no abnormality on the left side except that the cells were small. The right mastoid process, however, was reported as being markedly sclerotic with an irregular, poorly defined area of rarefaction in the epitympanic region, which was interpreted as a cholesteatoma. The roentgen examination was repeated to make certain that the two sides were properly identified on the film.

At operation, a large cholesteatoma was found in the left epitympanum. It had eroded into the anterior part of the horizontal semicircular canal and produced a large fistula. The roentgen findings on the right side were now interpreted as representing an ancient quiescent lesion.

This case demonstrates that a laboratory test, such as a roentgenographic examination, may be misleading and that, when laboratory findings conflict with clinical findings, the greater weight should be given to the latter.

**Carcinoma of the Thyroid Gland with a Solitary Metastasis to the Skull.** Hollis L. Albright. *New England J. Med.* 230: 573-576, May 11, 1944.

A 52-year-old female had a moderately firm, nontender mass measuring  $2.5 \times 1.0$  cm. in the right frontal area. Roentgen examination showed a defect involving both tables of the skull with slight secondary condensation of adjacent bone. A hard nodule was also found in the right lobe of the thyroid. The patient was operated upon and the thyroid nodule was removed. The mass in the right frontal area was also removed. Both specimens were found to be thyroid carcinoma. The patient was well, without evidence of further metastasis or recurrence, two and a half years later, justifying the surgical removal of both the primary and the metastatic malignant growth.

JOHN B. MCANENY, M.D.

**Radiography of the Neck of the Condyle.** A. Porter S. Sweet. *U. S. Nav. M. Bull.* 42: 1135-1139, May 1944.

A survey of the literature reveals numerous technics that can be used for examination of the condyle of the mandible, but these appear to have been developed primarily for examination of the temporomandibular joint and are often unnecessarily complicated. The author describes a simple technic, using a dental x-ray unit, based on a modification of the Schlegel method. This produces a satisfactory view of the neck of the condyle at the sacrifice of joint clarity.

The patient is seated in a dental chair with his head so placed that the interpupillary line of the eyes and an imaginary line from the ala of the nose to the tragus of the ear will be parallel to the floor. A cassette, which should rest against the cheek and ear securely so that no rocking will occur, is so positioned that the image of the condyle will be as near as possible to the center of the film. A large cork is placed between the incisors to bring the condylar neck forward as well as to insure against motion. The dental cone is removed from the tube-head and the tube is placed in contact with the opposite condylar neck so that the central ray passes directly through the neck of both condyles. Exposure factors must be determined for the particular machine in use. LESTER M. J. FREEDMAN, M.D.

## THE CHEST

**Primary Atypical Pneumonia. An Analysis of 738 Cases Occurring During 1942 at Scott Field, Ill.** Charles A. Owen. *Arch. Int. Med.* 73: 217-231, March 1944.

In 1942, at the Station Hospital, Scott Field, 799 patients were treated for pneumonia. Twenty-four had typical lobar pneumonia and 775 bronchopneumonia. Among the latter were 738 patients with clinical and laboratory findings suggestive of a non-bacterial cause.

Roentgenography is the most important, but not the sole means of diagnosis of atypical pneumonia. In general, the roentgen findings in this series were those which have become well established for this condition. A predilection for involvement of the lower lobe was marked, occurring in 612 cases, with a slight but definite predominance of the left lower lobe. Extensions of the pneumonic process occurred in 64 cases, with involvement of the opposite lung in 40.

The diagnosis of pneumonia was made in 15 cases with no definite roentgen changes beyond accentuation of truncal markings; this seemed justified from the clinical course and findings. In 30 cases the findings in the chest suggested pneumonia, while the initial films appeared normal, though the later ones were confirmatory. The detection of pulmonary signs prior to roentgenographic evidence is in sharp contrast to the usual minimal findings in the early stages. In 14 cases in which both the roentgen and thoracic findings were negative early but subsequently positive, pneumonia was suspected on the basis of the history and the general appearance of the patient.

Serious complications among the 738 cases of atypical pneumonia were rare; there were no fatalities. The disease showed epidemic tendencies during the late summer and fall when common diseases of the respiratory tract were at a minimum. Prolonged convalescence is the rule. From a military standpoint the time



lost is significant. Over 20,000 man-days were lost at Scott Field during 1942 from atypical pneumonia.

**Atypical Pneumonia Simulating Pulmonary Tuberculosis.** J. S. Yoskalka. *Am. Rev. Tuberc.* 49: 408-413, May 1944.

In recent years it has become apparent that atypical pneumonia can produce lesions which at times are indistinguishable from pulmonary tuberculosis. Seven cases of upper lobe atypical pneumonia were reviewed in order to determine, if possible, whether any diagnostic criteria could be established for this disease. The most common roentgen finding was an increase in bronchial markings manifested by linear streaking densities with superimposed mottled shadows. This process was found to be most pronounced at the hilum and to spread outwards in a fan-like manner toward the periphery. The other type of finding was an area of increased density in the parenchyma of the lung relatively uniform throughout, resembling the shadow seen in early pleural effusion. In some instances, evidence of atelectasis was present. There was a wide divergence of roentgenologic findings in the various cases at different times, and the authors feel that a definite differential diagnosis cannot be made from a single roentgenogram. Stereoroentgenograms are of value in diagnosis in doubtful cases. If the apical lesions fail to disappear within twenty days following the onset of the disease, the possibility of pulmonary tuberculosis should be entertained. This necessitates thorough investigation for tubercle bacilli, including a study of sputum and gastric contents and guinea-pig inoculation. One case is reported which was diagnosed as atypical pneumonia and which later proved to be tuberculosis.

L. W. PAUL, M.D.

**Bagasse Disease of the Lungs.** W. A. Sodeman and R. L. Pullen. *Arch. Int. Med.* 73: 365-374, May 1944.

Seven cases of bagasse disease of the lungs have previously been recorded. The authors summarize the findings in these cases and in 11 of their own. Two histories are presented in detail. All of the patients were men, with an average age of twenty-seven. Six patients were white, 5 were Negroes. The length of exposure to bagasse dust before symptoms arose was known in 8 cases and varied from three weeks to two years. A clear-cut history of exposure for only three weeks to two months was obtained in 3 of these cases.

The symptomatic picture was variable but showed several rather constant features. Cough and dyspnea were early and important symptoms, occurring in all cases. Dyspnea was almost invariably the presenting complaint; characteristically it appeared suddenly and became sufficiently severe within a few days to force the patient to rest. Examination of the chest showed nothing striking. Impaired resonance and diminished breath sounds were observed in 4 cases, usually in the bases of the lungs posteriorly. Roentgen examination of the chest revealed what was uniformly described as a miliary mottling throughout both lungs, most dense in the hilar areas. These areas in general had a ground-glass appearance. In only one case were the apexes involved. Ten of the 11 patients had leukocyte counts above 10,000, averaging approximately 13,000. In 7 cases differential counts indicated polymorphonuclear leukocytosis, the percentage of polymorphonuclear cells varying from 73 to 90. Eosino-

phils averaged 3.5 per cent. In 5 cases the sedimentation rate showed a definite increase.

Treatment consisted of rest in bed during the acute stage of the disease and palliative medication and procedures. The stay in the hospital varied from one to ninety-three days. A follow-up investigation of 5 cases over periods of four months showed perfectly clear roentgenograms of the chest in 3 and a residual which appeared to be clearing in one.

A fungus, an allergic reaction, tuberculosis, and pneumoconiosis have all been suggested as possible causes for this condition. Histologic study of the involved areas of the lung indicates the presence of bagasse dust with a severe and unusual cellular reaction, the nature of which has not yet been established.

**Pulmonary Hemosiderosis in a Six Year Old Boy: Clinical and Pathologic Report.** J. D. Pflieger and Oliver Eitzen. *Am. J. Dis. Child.* 67: 397-399, May 1944.

A 5-year-old undernourished white boy was hospitalized because of fatigability, muscular weakness, and anemia of three months' duration. On admission, examination of the blood showed 1,890,000 red cells, 19,000 white cells, and 20 per cent hemoglobin, with severe hypochromia, microcytosis, anisocytosis, and poikilocytosis. Tuberculin and Wassermann tests were negative. Roentgenograms of the chest showed an unusual diffuse, mottled infiltration, most dense at the hila, radiating throughout both lung fields almost to the periphery, "resembling miliary tuberculosis that had been flattened or squashed." The patient gave no history of previous lung disease, cough, or expectoration.

Several transfusions were given and the patient was discharged at the end of one month with a red cell count of 3,800,000, 16,000 white cells, and 70 per cent hemoglobin. The red cells had returned to normal, platelets and reticulocytes were abundant, liver function tests and clotting time were normal, but the bleeding time was slightly prolonged (six minutes) and the sedimentation index was 16 (normal 4-6). Re-examination of the chest showed no change. A diagnosis of chronic interstitial pneumonitis was made.

During the ensuing months the blood picture became normal, but progressively severe signs and symptoms of pulmonary fibrosis developed, including clubbing and cyanosis of the fingers and toes, brachial artery, and distinct enlargement of the pulmonary artery, evident clinically and roentgenologically. Death occurred about eighteen months after the onset of symptoms, from cardiac decompensation following an upper respiratory infection. The blood picture had remained normal in the interval.

While a diagnosis of hemosiderosis had been suggested roentgenographically, this was discounted clinically because of the absence of physical signs and the complete lack of sputum, bloody or otherwise. At autopsy, the alveolar and capillary walls were found to be variably thickened by fibrous tissue, and golden brown pigment was discovered free in the alveolar spaces and walls as well as in the numerous macrophages present. Several hilar nodes also contained pigment and phagocytic cells. Capillary hyperemia and focal hemorrhages were noted. Numerous small areas of fibrous tissue, reticulin, iron pigment, and calcium salts. A polarizing microscope revealed no silica.

The pathogenesis of the pulmonary and vascular fibrosis is discussed with particular consideration as to which was primary, but no conclusions are drawn. The opacities in the films were attributable to hemosiderin, which is a radiopaque decomposition product of hemoglobin from extravasated blood (Wells, H. G.: *Chemical Pathology*, 4th ed., Philadelphia, W. B. Saunders Co., 1920). The pigmentation was not, however, considered a primary cause of the disease, as it has been found in tissue without fibrosis. Widespread deposition of the pigment may occur from a focal hemorrhage, since hemosiderin is relatively insoluble and is only slowly removed from the tissues.

The roentgen illustrations show the progressive cardiac enlargement and the hilar adenopathy in the case reported but do not demonstrate the pulmonary infiltrations. The author compares his case to that of Anspach (*Am. J. Roentgenol.* 41: 592, 1939), which was strikingly similar pathologically but showed some clinical differences. LESTER M. J. FREEDMAN, M.D.

**Pneumothorax Due to Metastatic Sarcoma. Report of Two Cases.** T. F. Thornton, Jr., and Robert T. Bigelow. *Arch. Path.* 37: 334-336, May 1944.

Spontaneous pneumothorax in the presence of a primary neoplasm of the lung is uncommon. In the presence of a metastatic tumor of the lung it is extremely rare. Two cases of spontaneous pneumothorax due to metastatic sarcoma are reported. In one the primary growth was a spindle-cell fibrosarcoma of the flexor tendon of the thumb, in the other an osteogenic sarcoma of the femur.

**A Tumor Occurring in the Superior Pulmonary Sulcus.** Irving Imber. *Am. J. M. Sc.* 207: 654-660, May 1944.

Pancoast believed that the superior pulmonary sulcus tumor was extrapulmonary and extrapleural in origin. Others believe that most of the tumors so designated are bronchiogenic in origin, and that any tumor or inflammatory mass arising in the apex of the lung or in the pulmonary sulcus could produce the same syndrome. In the case recorded here a superior pulmonary sulcus tumor syndrome was produced by a tumor which was definitely extra-pulmonary. The clinical and radiographic findings were characteristic: (1) pain in the back, radiating to the arm, followed by atrophy of the muscles of the hand, (2) cough, (3) loss of weight, (4) Horner's syndrome, and (5) a mass in the apex of the hemithorax. The upper ribs and dorsal vertebrae and the sternum quickly became eroded. Later distant metastases appeared.

A superior pulmonary sulcus tumor was found at autopsy. It had invaded the sternum, the 1st and 2d ribs and dorsal vertebrae, the brachial plexus, and sympathetic ganglion, and had metastasized to the skin, peritoneum, and adrenals. Microscopically, the tumor was definitely extra-pulmonary. Since the actual source could not be determined, Pancoast's theory of origin from the precervical sulcus deserves consideration. BENJAMIN COLEMAN, M.D.

**Four-Inch Packing Nail in the Lung: Case Followed for Thirteen Years.** J. Blair Hartley. *Brit. J. Radiol.* 17: 157-159, May 1944.

An adult patient with a four-inch nail in the right lung, embedded in the middle lobe bronchus, was fol-

lowed for thirteen years without evidence of lung changes. During this period he had an attack of pneumonitis involving the right base, from which he recovered.

SYDNEY J. HAWLEY, M.D.

## THE DIGESTIVE SYSTEM

**Organic Upper Gastro-Intestinal Disease at an Advance Base.** John H. L. Heintzelman and Harold W. Jacox. *U. S. Nav. M. Bull.* 42: 1035-1037, May 1944.

At an advance naval base in the South Pacific, the case histories and films of 200 consecutive patients receiving x-ray examinations of the gastro-intestinal tract were studied to determine the incidence of organic disease and any diagnostic aids that would limit examinations to those patients likely to yield positive findings.

The most common chief complaint was epigastric pain or distress. Complete histories were obtained for all but a few out-patients and were classified as typical for ulcer if the pain was in relation to meals, with relief by food or medication, or if hematemesis were present with or without pain. All other histories were considered atypical.

The type of history and age group are considered of definite value in determining the need of a gastro-intestinal series. Of the 200 patients, 64 gave typical histories and 22 had demonstrable ulcers. Of these 22 patients, 16, or 73 per cent, had typical histories. Of the 200 patients examined, 101 were under thirty years of age; 17 of the 22 patients with ulcer were older than thirty years.

Service at home or abroad apparently has little effect on the production of ulcer, since 80 of 124 patients with negative x-ray findings and 15 of the 22 with ulcer had symptoms while in civil life.

A plea is made for more careful study and observation of patients before gastro-intestinal series are ordered. The presence of psychoneurosis, malaria, hookworm, or other conditions may become apparent, either nullifying the need of these examinations or demanding transfer of the patient to a mainland hospital, where x-ray studies can be made if deemed necessary. LESTER M. J. FREEDMAN, M.D.

**Surgical Treatment of Esophageal Atresia and Tracheoesophageal Fistulas.** Wm. E. Ladd. *New England J. Med.* 230: 625-637, May 25, 1944.

The various types of esophageal atresia and tracheoesophageal fistulas are diagrammed and described. The diagnosis is suspected when a newborn infant has an excess of saliva and possibly a cyanosis. There may be immediate vomiting of the feedings. Examination of the chest may disclose moist râles from aspirated saliva. Abdominal examination may reveal distention with tympany or complete flatness, according to the type of malformation. With these findings the next step is to insert a small catheter into the esophagus. Obstruction encountered 10 to 12 cm. from the lips, practically establishes a diagnosis of atresia. This, however, should be checked fluoroscopically, with a small amount of iodized oil, but never barium. Roentgenograms are reproduced showing the failure of the catheter to pass beyond the point of obstruction and demonstrating, also, distention of the stomach and intestines.

Postmortem examinations show that there are fre-

quently one or several accompanying congenital abnormalities in these patients.

Various surgical procedures for dealing with this abnormality are discussed and new methods that have proved successful are advocated. The outlook is not entirely hopeless.

JOHN B. McANENY, M.D.

**Volvulus and Incarceration of Stomach in a Diaphragmatic Hernia with Complete Gastric Obstruction. Operative Recovery with Obliteration of Hernial Sac by Tamponade.** Martin G. Vorhaus and DeWitt Stetten. *Gastroenterology* 2: 307-315, May 1944.

A case of left diaphragmatic hernia is reported. Attacks of pressure, apparently induced as a result of conscious or subconscious emotional reactions and relieved by spontaneous or induced belching or vomiting, finally terminated in a volvulus of the distal half of the stomach, with rotation anteriorly and upwards. The subsequent incarceration of the antrum in the left hernial sac, with complete kinking, produced total acute gastric obstruction, as shown by roentgenograms.

At operation, the volvulus of the stomach was reduced without much difficulty, and in addition a pouch of the fundus of the stomach adjacent to the cardia, found in the hernial sac, was withdrawn. Because of the patient's critical condition and the inaccessibility of the hernial ring, a method of obliteration of the hernial sac by tamponade was employed.

Twenty days following the operation, one of the tampons was removed and a catheter was inserted about 8 inches into the drainage tract. The following day hippuran was injected through the cavity previously occupied by the incarcerated stomach. About 40 c.c. of hippuran was required to fill the cavity, which measured about 7 cm. in diameter. A roentgenogram showed all of the stomach wall below the diaphragm. Six days later the remaining tampons were removed. The catheter was left in place and x-ray studies were continued. These studies revealed a progressive and practically complete obliteration of the hernial cavity.

Roentgenograms are reproduced.

**Primary Carcinoma of the Jejunum and the Ileum.**

P. G. Boman. *Ann. Int. Med.* 20: 779-788, May 1944.

Carcinoma of the small bowel comprises from 0.47 per cent to 6.0 per cent of all carcinomas of the gastro-intestinal tract, according to different reports. Ewing's estimate of 3.0 per cent is probably correct. Adenocarcinoma is the predominant type, accounting for over 90 per cent of operated cases. It is usually of the annular, constricting type, but may be polypoid, ulcerating, and non-constricting. Melanocarcinoma and scirrhous carcinoma, though rare, have been reported. Metastasis occurs early and, according to Mayo and Nettrour (*Surg., Gynec. & Obst.* 65: 303, 1937) involves first the mesenteric lymph nodes and peritoneum, then the liver, lungs, long bones, and dura mater of the spinal cord, in the order named.

The onset of symptoms is most insidious and the duration variable, ranging from a few weeks to several years. Antedating the obstructive stage, one usually finds weakness, early fatigability, weight loss, and anemia, due in part to interference with the normal function of the small bowel, both as to motility and absorption, and in part to the occult blood loss.

As the growth increases in size and narrows the lumen of the intestine, symptoms and signs of obstruction, such as pain, abdominal distention, nausea and

vomiting appear. These may be intermittent in character, usually increasing in frequency and severity as the obstruction increases. Pain may vary from a vague discomfort to severe colic, depending upon the degree of stenosis. It is usually located in the umbilical region and the lower quadrants of the abdomen. Steady pain in the epigastrium is a late symptom and probably results from metastasis to the retroperitoneal lymph nodes. Constipation is frequent, although diarrhea alternating with constipation or normal bowel movements may occur. Loss of weight is a prominent and constant finding. Visible and reverse peristalsis are occasionally seen. An abdominal mass indicates advanced disease.

A definite diagnosis can be made only roentgenologically or by exploratory operation. Until recent years, few cases were diagnosed prior to operation or autopsy. The roentgen examination is exacting and time-consuming and cannot be used routinely in many laboratories. Even in the hands of skilled roentgenologists, only about 25 per cent of these lesions can be demonstrated, but the indirect evidence may be sufficient to make a fairly accurate diagnosis in a larger percentage of cases.

The treatment of choice is radical resection, with end-to-end or lateral entero-anastomosis. If this is not practicable, a palliative entero-anastomosis around the growth is indicated. Postoperative roentgen therapy may be justified.

The prognosis, regardless of whether or not the growth is removed, is discouraging. Most of the patients now living have not had a sufficiently long follow-up to give an accurate picture of the real prognosis.

The author analyzes in detail 3 cases of adenocarcinoma of the jejunum and 4 of the ileum and includes the case histories. There were 4 males and 3 females in the series, with ages ranging from 27 to 71 years, the average age being 51 years. The duration of symptoms was from three weeks to three years or more, averaging fifteen months. The main symptoms were weight loss (varying from 10 pounds to 60 pounds and averaging 26 pounds), weakness, fatigue, abdominal pain, anorexia, vomiting, and anemia. The hemoglobin varied from 32 per cent to 89 per cent, with an average of 57 per cent; the red cell count was from 2,570,000 to 4,840,000, with an average of 3,570,000.

Resection and entero-anastomosis were done in 6 instances and palliative entero-anastomosis around the growth in a single case. Metastases to the mesenteric nodes were present in all patients, and involvement of the omentum and peritoneum was found once. There were 3 postoperative deaths. Two patients, are still living and the other 2 lived six months and two years respectively. The pathological diagnosis in each instance was adenocarcinoma.

It is important that in all patients presenting vague and indefinite gastro-intestinal symptoms and an unexplained anemia cancer of the small intestine be considered a possibility.

STEPHEN N. TAGER, M.D.

**Abdominal Aortic Aneurysm: Rupture Into the Jejunum Preceded by Occult Blood.** Glenn I. Hiller and Richard M. Johnson. *Am. J. M. Sc.* 207: 654-660, May 1944.

Rupture of an abdominal aneurysm with perforation into the gastro-intestinal tract has been reported less than 25 times. Most of the cases have involved

the duodenum. The third portion of the duodenum is relatively immobilized against the vertebral column and aorta by the pancreas, mesocolon, and ligament of Treitz. This intimate relationship probably accounts for the predilection of aneurysms in this region to rupture into this portion of the bowel. It is also probable that the pressure exerted on the relatively immobilized duodenum accounts for some of the symptoms.

In general, abdominal pain, usually epigastric, and indigestion followed by anorexia and weight loss, are the most frequent complaints. The duration of the symptoms is usually less than one year. Occult or gross blood may be found in the stools.

Roentgen evidence, when present, consists in pressure defects on adjacent structures. Fluoroscopy of the upper gastro-intestinal tract may reveal and localize an extrinsic pulsating mass. Erosion of the lumbar spine may occur, or displacement of such adjacent organs as the left side of the colon or of the left kidney. Calcification may be demonstrated in the aneurysmal sac.

A case is reported of rupture of an abdominal aneurysm in a white male aged 76, who complained of abdominal distention and pain of sudden onset five weeks before admission. Moderate tenderness was present in the epigastrium. The liver was slightly enlarged. All laboratory and roentgen studies were within normal limits, except for the persistent finding of occult blood in the stool on five occasions. Death occurred suddenly two weeks after admission. At autopsy, an arteriosclerotic abdominal aneurysm at the site of a large atheromatous ulcer was found. It had ruptured into the left retroperitoneal tissues and into the jejunum just below the duodenojejunal junction. Another small aneurysm was found involving the aortic arch.

BENJAMIN COLEMAN, M.D.

**Clinical and Radiological Observations Concerning the Large Pendulum Movement of the Colon.** A. Galambos. *Am. J. Digest. Dis.* 11: 151-158, May 1944.

The pendulum movement of the colon is the only one that does not move its contents. This movement is usually restricted to the transverse colon. With the hepatic and splenic flexures as fixed points, the mid transverse portion swings outward and upward. In ptotic persons this may change the position of the mid transverse colon from the region of the symphysis to the level of the xiphoid process.

In an analysis of colon movements, the patient must be in the same position and in the same phase of respiration for each film.

The author has attempted to group together under several headings the types of movements described by various writers, under different names. The small pendulum movement is one which is frequently described. It causes continuous changes in the contour of the colon and has for its purpose the mixing of the colon content. A second movement is described as "promoting peristalsis." This type of movement propels the contents along the colon by changing the form of its larger segments. The third is the *en masse* movement, which carries a large amount of fecal material along a considerable area of the colon. The fourth is the large pendulum movement first described by Rieder, which the author discusses in detail.

JOSEPH T. DANZER, M.D.

**Value of the Opaque Enema and Its Modifications.** Norman P. Henderson. *Brit. J. Radiol.* 17: 140-149, May 1944.

On the two nights prior to an opaque enema examination, the patient should take a mild laxative. Castor oil is undesirable because of its unpleasant taste and because it frequently produces gas and spasm in the colon. Two or three hours before the examination, two plain water enemas should be given. A scout film should be made before the opaque medium is administered.

The standard procedure is still the most useful. The barium should be watched as it flows in, and the colon should be completely and evenly filled. The author discusses the application of the standard technique to the diagnosis of tumors of the large bowel and extracolonic lesions. While carcinoma of the rectum is not really within the province of the radiologist, a growth difficult to diagnose clinically may sometimes be demonstrated roentgenographically. Cases of megacolon are likely to be misleading, and an associated neoplasm may be overlooked. Early carcinomas of the bowel, occupying only a segment of the lumen, may be difficult to detect, and oblique views may be helpful. The author cites illustrative cases of these and other new growths. Examples of extracolonic conditions mentioned include ovarian tumor, bladder distention due to prostatic hypertrophy, and ruptured pelvic abscess.

Local compression combined with the standard enema may be of value. The compression should be carried out in connection with the evacuation roentgenogram, when usually only a small amount of barium is left in the bowel, and interpretation of results should be made "with the strictest reservation."

The use of air inflation following evacuation of the enema is particularly useful in the diagnosis of diverticulosis. In this connection the author describes an "anti-incontinence device" that has proved of value.

Further modifications of the standard procedure are the use of other opaque media than barium and the so-called "reduction density technic." The former seems to offer little advantage. The latter is sometimes of help in the demonstration of polyposis. The patient is first given a standard enema and allowed to evacuate it, after which a second enema, diluted 1 to 20, is administered.

In obscure cases of colitis, particularly ulcerative colitis, the inclusion of a chest film is advised to assist in the establishment or exclusion of tuberculosis as the basis of the intestinal infection.

SYDNEY J. HAWLEY, M.D.

## THE SKELETAL SYSTEM

**Seasonal Variations in Weight, Height, and Appearance of Ossification Centers.** Earle L. Reynolds and Lester Warren Sontag. *J. Pediat.* 24: 524-535, May 1944.

The authors investigated seasonal variations in weight and height and in the appearance of specific ossification centers in 133 children during the age span from twelve to sixty months. Seasonal variations, similar in the sexes, were found to exist in each of the three categories. The variation in weight was pronounced; in ossification, moderate; and in height, slight. Seasonal variations in height and ossification were parallel and opposite to the seasonal varia-

tion in weight. The period of maximum weight gain was from October to December; minimum weight gain, from April to June. The period of maximum height gain was from April to June; minimum height gain, from October to December. The period of maximum rate of appearance of ossification centers was from March to May; minimum rate of appearance, from September to November.

Fluctuations in individual growth curves, based on semiannual measurements, were shown to be sharply responsive to seasonal differences in rate of growth. Analyses of deviations in such growth curves, therefore, should take into consideration the season of the year which is covered by the interval between measurements.

**Chondrodystrophia Calcificans Congenita.** Maxwell P. Borovsky and Julian Arendt. *J. Pediat.* 24: 558-567, May 1944.

An unusual case of congenital maldevelopment is reported in a 10-day-old infant. The knees were flexed to a 30-degree angle, and the left leg could not be extended. The findings were at first attributed to breech delivery, but re-examination in two weeks showed an aggravation of the condition and roentgenograms were made. These revealed abnormal calcification in the left knee, filling the entire upper patellar recessus and extending downward to the interarticular space. While this deposit was coherent, resembling a wax imprint of the entire capsule space, posteriorly many more round and sometimes irregular calcified bodies were seen. A few "stippled shot-like densities" were apparent in between, as well as at the foot and wrist. There was a periosteal elevation along the anterior surface of the femur. Similar changes were observed in the right knee. There were onion-peel-like periosteal elevations along both femora and a slight periosteal thickening along the tibiae. The proximal epiphyses of both humeri were well developed. Some "stippled densities" were observed beneath the epiphyseal center of the humerus. A chest film showed enlargement of the heart and thymus.

A month later, multiple stippled calcareous deposits were demonstrable in the distal row of the tarsal bones. The proximal and distal epiphyses of the tibia and femur were well developed, and the astragalus and os calcis were of normal density and showed no stippling. Changes similar to those seen in the tarsal bones were present in both wrists. The knee joints showed multiple round and partially sickle-shaped calcifications. The patellar and epiphyseal cartilage was outlined as a negative shadow by the surrounding calcium wall. The capsule appeared thickened and filled out with numerous irregular calcifications. The distal femoral epiphysis was normal but slightly smaller on the left side. The bone structure of the shafts and the epiphyseal lines appeared normal. There was a slight flaring of the metaphyseal ends of the tibia and femur.

There was no history of thyroid disturbance in the mother and no clinical or laboratory evidence of thyroid deficiency in the infant. The development of the carpal bones was normal. Kahn and Kline tests were negative. When the infant was one month old, the blood calcium was 11.9, phosphorus 4.8, and phosphatase 72 King units.

A biopsy specimen from the left knee showed large masses of calcific deposits staining a deep purplish color. They were surrounded in places by a pink,

fairly homogeneous tissue which was infiltrated with large numbers of mononuclear and occasional polynuclear giant cells, engulfing the calcific deposits and having the appearance of foreign-body giant cells. The pathological diagnosis was calcification of synovia, with reactive inflammation.

Casts were applied to the legs to correct the contractures. When the patient was one year of age, x-ray films showed almost complete absorption of the calcium deposits and the appearance of normal bone formation in the metatarsal area where stippled bone was previously present.

This condition was first described by Conradi in 1914. Raap (*Am. J. Roentgenol.* 49: 77, 1943) applied to it the term *chondrodystrophia calcificans congenita*.

**Palindromic Rheumatism.** A "New," Oft Recurring Disease of Joints (Arthritis, Periarthritis, Para-Arthritis) Apparently Producing No Articular Residues—Report of Thirty-Four Cases; Its Relation to "Angioneural Arthrosis," "Allergic Rheumatism" and Rheumatoid Arthritis. Philip S. Hench and Edward F. Rosenberg. *Arch. Int. Med.* 73: 293-321, April 1944.

Palindromic rheumatism is a term applied by the authors to an unusual disease of joints and adjacent tissues, 34 cases of which have been studied in the arthritis service of the Mayo Clinic since 1928. Its outstanding features are multiple afebrile attacks of acute arthritis and periarthritis, and sometimes also of para-arthritis, with pain, swelling, redness, and disability, usually though not always confined to a single joint, in an adult of either sex. The attacks appear suddenly and develop rapidly. They generally last only a few hours or days and then disappear completely, but they recur repeatedly at short or long, irregularly spaced intervals, involving first one joint and then another. In most of the authors' cases four to six joints were affected; in others eight to eleven.

Despite the frequent recurrences and the transitory presence (in some cases at least) of an acute or subacute inflammatory polymorphonuclear exudate in the articular tissues and cavity, little or no constitutional reaction or abnormality is revealed by laboratory tests, and no significant functional, pathologic, or roentgenographic residues occur even after years of disease and scores of attacks. Of the 164 roentgenograms of various joints made in the 34 cases, 150 (91 per cent) revealed nothing significant; the remaining 14 (9 per cent) showed changes regarded as unrelated to the chief complaint.

The chief points which distinguish the cases of palindromic rheumatism from instances of rheumatoid arthritis are: (1) the totally different pattern of the arthritis (numerous short attacks and persistent functional restitution); (2) the tendency for only one or two joints to be involved in an attack; (3) the frequent isolated short attacks of para-arthritis; (4) the general absence of significant constitutional reactions; (5) the relative absence of effect of season and weather; (6) the sedimentation rate, which is relatively normal or only moderately and transiently elevated; (7) the moderate increase (rather than decrease) in blood fats; (8) the persistently negative roentgenograms, (9) the different pathologic reaction.

The absence of fever during the attacks, the short duration of the attack, the monarticular rather than polyarticular involvement, absence of hives or angio-

neurotic edema accompanying the attacks, the more advanced age of the patient, the presence of an inflammatory exudate or edema distinguish these cases from the condition described by Solis-Cohen in 1913 and termed "angio-neural arthrosis."

This condition also resembles "allergic rheumatism" described by Kahlmeter in 1939. Local redness was usually absent in Kahlmeter's cases; it was usually present in the authors' cases. Kahlmeter's patients occasionally had fever and erysipeloid rashes; none of the cases in the present series did. The frequency of the common allergic reactions was much greater in his cases than in the authors'.

The prognosis for a spontaneous cure in palindromic rheumatism is only fair. Of 27 patients whose condition is known, 15 per cent are now well, 44 per cent are improved somewhat though not notably, 26 per cent are as before, 11 per cent are somewhat worse, and 1 died of causes unrelated to the arthritis.

**Osgood-Schlatter Disease.** Edmond Uhry, Jr. Arch. Surg. 48: 406-414, May 1944.

On the basis of clinical studies on 79 patients and pathologic studies of operative specimens from 20 of that number, the author concludes that Osgood-Schlatter disease develops on the basis of minor separation of the structures comprising the tibial tubercle and patellar ligament. This opinion was first advanced by Osgood and Schlatter. The characteristic pathologic changes are interpreted as being due to scar and callus formation about the fracture site. Occasionally the detached tip of the tubercle forms a pseudarthrosis. The explanation of the lack of marked separation due to quadriceps pull lies in the patellar collateral ligaments, which will preserve the function of the joint and the position of the bones even after removal of the tibial tubercle and the attachment of the patellar ligament. The age distribution of the lesion is apparently due to the weakness of the part and its susceptibility to trauma in the prepubertal period. Inflammation, osteochondritis, and endocrine disturbances seem to have no relation to this condition. Trauma is the immediate instigating factor. The most logical treatment would appear to be early immobilization, but spontaneous healing may occur.

Roentgenograms in the author's cases showed, in the first place, more or less fuzziness of the border shadow of the tibial tubercle. Sometimes it also appeared that the tongue had been pried slightly upward, its prominence being increased and the space between it and the underlying tibia being abnormally wide. Occasionally, what appeared to be a shadow of a free bony fragment could be observed lying in the ligament above and in front of the tubercle. In some instances, in which roentgenograms of serial sections were made after removal of the region *en masse*, the evidence of loss of local definition in the bone-cartilage or bone-ligament border shadows was even more apparent. In some of them the translucent or transparent shadow of a scar could be seen interposed between the bulk of the osseous apophysis and a small shadow of a flake of bone, actually avulsed forward in the process of separation. The general softness of the normal roentgen shadow of the growth zone (posterior surface of the apophyseal plate) tended to obscure the changes when they occurred in that region.

LEWIS G. JACOBS, M.D.

**Eosinophilic Granuloma of Bone Presenting Neurologic Signs and Symptoms.** Report of a Case. Raymond L. Osborne, Edward D. Freis, and Alfred G. Levin. Arch. Neurol. & Psychiat. 51: 452-456, May 1944.

Following a brief review of the various features of eosinophilic granuloma and presentation of a table of differential diagnosis which includes fifteen separate osseous entities, the first reported case of eosinophilic granuloma presenting neurologic symptoms and signs is recorded.

The patient, a twenty-one-year-old soldier, complained first of facial palsy. Headache, giddiness, vomiting, deafness, tinnitus, vertigo, and deep-seated pain in the ear developed later. Abnormalities noted in the neurologic examination were confined to the cranial nerves. Roentgenograms showed solitary or confluent polycystic lesions in the left temporal bone, the mandible, the seventh cervical vertebra, the first two dorsal vertebrae, multiple ribs on both sides, the right femur, and the fifth lumbar vertebra. Histologic examination of biopsy specimens showed typical eosinophilic granuloma.

Roentgen therapy produced a favorable response.

DEPARTMENT OF ROENTGENOLOGY  
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**Actinomycosis of the Vertebrae.** Mortimer Lubert. Am. J. Roentgenol. 51: 669-676, June 1944.

Involvement of the vertebrae is a rather uncommon manifestation of actinomycosis. Its occurrence indicates extensive disease and the prognosis is hopeless. A review of the literature in 1935, by Meyer and Gall (J. Bone & Joint Surg. 17: 857, 1935) resulted in a collection of 47 cases.

The roentgen findings in vertebral actinomycosis may be characteristic if not pathognomonic. Erosion of all portions of the vertebrae and adjacent ribs, including the pedicles, spine, lamina and body is a feature. The body is usually affected in its cortical portion, with periostitis as an early manifestation. The anterior surface may have a saw-tooth appearance. Reactive condensation takes place about destroyed areas and the vertebra involved may appear denser than its neighbors. The intervertebral disk is usually not affected.

In the present paper 3 cases are reported, with illustrative roentgenograms. Two of the patients showed the classical findings as described above, while one showed extensive collapse of the involved vertebral body, which is unusual. In one instance the involvement of the vertebra was apparently secondary to primary mediastinal involvement. In the second case there was an ileocecal actinomycosis with subsequent spread to the lumbar prevertebral tissues and vertebrae, and in the third case there was a primary pulmonary actinomycosis with secondary involvement of the mediastinum and vertebra. Two of the three patients gave no history of contact with grasses or cattle.

In differential diagnosis, tuberculosis and non-specific osteomyelitis must be considered. Occasionally they may give findings similar to those seen in actinomycosis. In tuberculosis, however, involvement of the intervertebral disk with narrowing of its space and finally collapse of the vertebral bodies is the rule. In non-specific osteomyelitis, biopsy and bacteriological examination must be resorted to if the rest of the clinical picture is not conclusive.

L. W. PAUL, M.D.



**Maduromycosis of the Hand, With Special Reference to Heretofore Undescribed Foreign Body Granulomas Formed Around Disintegrated Chlamydospores.** Douglas Symmers and Andrew Sporer. *Arch. Path.* 37: 309-318, May 1944.

The case here reported is the first example of maduromycosis of the hand to be described in the United States, the second on the North American continent, and the fifth thus far recorded. It is further remarkable because of its occurrence in a man of 67 years who had never been outside the city of New York. The disease developed about three weeks after he fell on a wooden floor and sustained multiple abrasions of the palmar surface of the right hand, through which presumably the infective fungus entered.

Contrary to the opinion of Chalmers and Archibald (New Orleans M. & S. J. 70: 455, 1917-1918), the authors believe that maduromycosis and actinomycosis are different diseases and that the histology of the former is distinctive. The granuloma of maduromycosis is formed around degenerate chlamydospores; that of actinomycosis, around ray fungi. Both are foreign body reactions but they bear only a remote resemblance to each other. The causative fungi are closely related.

The patient was admitted to the hospital in July 1937. During the preceding seven years he had suffered repeated "strokes," which left him with a weakness of the right side of the body. Two years before admission he incurred the injury to the hand described above. Two or three weeks after this the hand became swollen, and multiple pustules appeared with black dots in them. At the time of admission the hand was greatly swollen and showed many nodular formations on both the palmar and dorsal aspects. Some of these nodules contained sinuses which discharged yellowish pus and black granules. Springing from the tendon sheath of the extensor muscle of the right ring finger was a solitary cyst-like formation. Throughout the rest of the hand there were multiple subcutaneous nodules, which were moderately firm in consistency, movable, painless, and not tender. At times, during the period 1937 to 1944, acute exacerbations occurred, the nodules becoming enlarged, hot, red, and tender, and the hand as a whole increasing in size.

In 1939 roentgenograms of the hand showed areas of decalcification in the semilunar bone and os magnum and an area of ossification in the soft tissues adjacent to the metacarpophalangeal articulation of the thumb. An osteophyte was observed at the articular margin of the distal phalanx of the thumb and there were productive changes at the upper and lateral margin of the proximal phalanx of the third finger. The soft tissues of the hand and those about the proximal interphalangeal articulations of the ring and middle fingers were considerably swollen. During the next three years these changes advanced and by 1944 marked roentgen evidences of progression were present.

At the time of the report, the patient was partially paralyzed on the right side. The blood pressure varied from 220/100 to 210/150. Scattered over both surfaces of the right hand were numbers of discrete, freely movable, painless and non-tender nodules. Over many of them the skin was speckled by minute black deposits. Other nodules were surmounted by cup-like depressions from 1 to 5 mm. in diameter, encrusted by the same sort of black material. These represent the openings of fistulous tracts which formerly exuded

mucopurulent material containing particles resembling grains of gunpowder. The hand was greatly enlarged, deformed, and almost useless.

The most striking histologic feature of this disease is the focal lesions which the authors call "maduromycotic granulomas" in contradistinction to the "granulomas" of actinomycosis. The granulomas of maduromycosis are of three types, of different ages, all of them built around pigmented chlamydospores, which in some places are well preserved and in other places are necrotic. One type is immature and the disintegrated chlamydospores in it are displayed against a background composed almost entirely of polymorphonuclear neutrophilic leukocytes. Encapsulation, if present, is ill defined. The second or intermediary form contains clumps of disintegrated chlamydospores and young giant cells, many of which present curious configurations and are poor in nuclear chromatin. Granulomas of this type are often encapsulated, usually by young connective tissue. The third type of granuloma is mature. The giant cells in it engage in phagocytosing waste material derived from the disintegration of chlamydospores. In some instances the mature granuloma is encapsulated by well organized connective tissue; in others, by connective tissue that is cellular and obviously young.

**Boeck's Sarcoid and Systemic Sarcoidosis. (Besnier-Boeck-Schaumann Disease.) Study of 35 Cases.** David Reisner. *Am. Rev. Tuberc.* 49: 437-462, May 1944.

The present paper, the second in a series, deals with the clinical aspects of Boeck's sarcoid and discusses the types of lesions observed in the skin, the bones, the visceral organs, the eyes, parotid gland, and other locations. [The first paper, dealing with pulmonary lesions and involvement of the lymph nodes, was abstracted in the December 1944 issue of *RADIOLOGY*, page 600].

Skin lesions were present in 40 per cent of the 35 cases upon which this discussion is based, and manifest bone changes in about one-fourth. Involvement of the eye and its adnexa and of the spleen and liver was of fairly frequent occurrence. Visceral localization, especially in the lungs and lymph nodes, was far more frequent than involvement, for example, of the skin and bones, which has been considered as more characteristic. Outstanding among the general clinical characteristics of sarcoidosis are its chronic protracted course, the disproportion between the widespread anatomical involvement and the apparently good general health of the patient, as well as a pronounced tendency to spontaneous regression of the lesions in various organs.

When the bones are involved by the characteristic form of the disease, the changes are practically pathognomonic and, therefore, of great diagnostic value. The typical roentgen appearance is the osteitis tuberculosa multiplex cystoides of Jüngling. Two main types of lesions are observed: (1) the circumscribed form, consisting of sharply defined punched-out areas of rarefaction, usually situated in the medullary portion of the bone, without any accompanying reactive change; (2) the diffuse form, which produces either a lattice-like appearance of the bony structure due to multiple small, irregularly shaped areas of rarefaction, or a diffuse, finely reticulated lace-like pattern, or a combination of both. These changes are most commonly found in the bones of the hands and feet; less



often in other parts of the skeletal system. Subjective symptoms due to the osseous lesion are usually absent, although in the early stages slight change may be present. Spontaneous regression of the bone lesions may occur.

In the author's series, 40 per cent of the patients reacted positively to tuberculin tests. This appears to be considerably below the expected figure for a comparable average population, and a negative tuberculin reaction is of some value in differential diagnosis. Examinations of the sputum and gastric content for tubercle bacilli were consistently negative throughout the period of observation of these patients except those in whom manifest pulmonary tuberculosis developed during the course of observation. When the predominant location of the disease is in the visceral organs, differential diagnosis includes particularly Hodgkin's disease and disseminated hematogenous forms of tuberculosis. For a conclusive diagnosis, biopsy is often indispensable in cases of this type. Tuberculosis accounted for most of the fatal cases in the present series, 7 of the 35 patients having died. This observation, together with the occurrence of atypical cases occupying a borderline position between sarcoïdosis and tuberculosis, indicates a close relationship between these two diseases. L. W. PAUL, M.D.

**Traumatic Separation of the Upper Femoral Epiphysis. A Birth Injury.** Putnam C. Kennedy. *Am. J. Roentgenol.* 51: 707-719, June 1944.

Traumatic separation of the upper femoral epiphysis at birth is a rare lesion, probably no more than 30 cases being reported in the literature. Many of these cases are reviewed and the significant data included in the present paper. The author reports, in addition, one case of his own.

In all of the previously reported cases the separation occurred during breech presentation and extraction or version and breech extraction. In the author's case, however, there was no known difficulty in extraction of the legs, the fetus being in vertex presentation and occipito-posterior position.

Pathologically, when the upper femoral epiphysis is dislocated at birth, the cartilaginous mass as a whole is displaced medially and downwards off the curved upper surface of the shaft. The periosteum is stripped up for a variable distance along the shaft, sometimes as far as the distal end. There is hemorrhage at the site of epiphyseal separation and beneath the periosteum. The joint capsule remains intact, however, and the cartilaginous femoral head remains lodged in the acetabulum, so that no dislocation of the hip joint is present. The injury is followed by the rapid production of bony callus, which forms a large, irregular mass around the proximal end of the shaft and the displaced epiphysis. This is larger in amount, as a rule, on the upper outer aspect. Beneath the periosteum new bone formation takes place rapidly. With organization and absorption, the club-like mass gradually disappears and the femoral shaft and neck are reconstructed and remodeled.

The clinical signs of the injury consist in swelling, a slight shortening, limitation of active motion, painful passive motion, and external rotation of the thigh. There may also be discoloration, crepitus, and abduction or adduction. The roentgenographic signs consist in displacement of the proximal end of the diaphysis, upward and outward, in its relationship to the ace-

tabulum, rapid and profuse callus formation and subperiosteal reaction around the upper end of the shaft, gradual absorption of callus and reconstruction of the femoral neck over a period of months, and premature ossification of the capital epiphysis and accelerated growth of the femoral neck on the injured side. The diagnosis is more readily made after callus becomes visible, and this usually occurs during the second week. It can be made earlier, however, if attention is paid to the relationship of the upper end of the diaphysis and the acetabular fossa. L. W. PAUL, M.D.

**Lesions of the Acromioclavicular Joint Causing Pain and Disability of the Shoulder.** Albert Oppenheimer. *Am. J. Roentgenol.* 51: 699-706, June 1944.

The acromioclavicular joint plays an important part in determining the mobility of the shoulder girdle, and diminished mobility of this joint will interfere with most of the movements of the arm in the shoulder. For the best roentgenographic demonstration of this joint, the central ray should be perpendicular to the wing of the scapula at the level of the acromion. This may be achieved either by placing the patient supine, with the shoulder blade of the involved side flat on the table, or by having the patient stand upright with his back to the film and the shoulder drawn backwards, like a soldier standing at attention.

The normal joint space in the acromioclavicular joint varies between 2 and 5 mm. in width, as measured in roentgenograms taken at 36 in. An unusually wide joint space may indicate the presence of an articular disk, which is sometimes found as a normal variation. The articular bony surfaces are smooth and clean-cut; as seen edgewise, they may be straight, notched, concave, or convex and may differ in shape in the two joints of the same person.

In addition to fractures and dislocation, the acromioclavicular joint may be the seat of any of the various types of arthritis. Thus, tuberculous arthritis, gonorrheal arthritis, and rheumatoid and hypertrophic arthritis may be encountered, producing roentgenographic changes similar to those in other peripheral joints. Hypertrophic arthritis is the most common lesion of the acromioclavicular joint, its incidence being about twice as high as that of all other lesions combined. It produces definite disability of the shoulder. Roentgenograms show the capsule enlarged, usually with moderate widening of the joint space. In the more advanced stages, the articular surfaces are eburnated and roughened, and their margins may show bony overgrowth. The joint space may then become diminished. Irrespective of its kind and stage, arthritis of the acromioclavicular joint causes pain in the shoulder, often radiating into the arm, wrist, and fingers, with definite limitation of the movements involved in bringing the arm above shoulder level across the chest and onto the back. Pronation and supination are not limited as a rule, and this serves to distinguish involvement of this joint from that of the shoulder joint proper.

In 11 patients with chronic arthritis of this joint treated with roentgen rays, 5 became symptom-free and have remained so for over six months. Treatment consisted of doses of 50 to 70 r, with 140 kv., 0.5 mm. Cu plus 1 mm. Al filtration, 50 cm. distance, applied to fields 5 cm. square and given at intervals of four to five days. In some patients relief was noted after the second treatment, while in others six to eight treat-

ments were required to bring about complete or nearly complete relief.

It is emphasized that the clinical manifestations of the various acromioclavicular lesions may be virtually identical with those caused by bursitis, myalgia, radicular neuralgia, and traumatic injury of the shoulder girdle, and that the correct diagnosis is determined by the roentgen findings in a majority of the cases.

L. W. PAUL, M.D.

**Fracture of the Carpal Scaphoid.** Jeffrey M. Robertson and R. D. Wilkins. *Brit. M. J.* 1: 685-687, May 20, 1944.

The authors quote Wilson [though they give no reference] as stating that 86 per cent of carpal injuries involve the scaphoid and, by contrast, Hook and Boone (*U. S. Nav. M. Bull.* 34: 172, 1936), who found the incidence to be only 1 in 10. The cause is usually a fall on the outstretched hand or forced dorsiflexion of the wrist, and the symptoms are pain, swelling, and tenderness in the anatomical "snuff box." Diagnosis is made roentgenographically, four positions being recommended—anteroposterior, lateral, and two oblique. The authors' patients, 100 in number, were sailors and airmen, and the average age was 27 years.

Treatment consists in prolonged plaster-of-paris immobilization in slight dorsiflexion with the thumb in line with the long axis of the radius and slight radial deviation. For 52 of the authors' series treated within seven days of the injury, the average period of immobilization was 11.16 weeks and union was obtained in all. For 48 patients treated after greater intervals—a week to several months or even years—much longer periods of immobilization were required; the average for 13 in whom union was eventually obtained was 26 weeks. Twenty-nine of these late cases failed to show union. Operative treatment was undertaken in 12 of this number, but in only 5 was union achieved and but 3 of the 5 patients could be returned to full duty.

The importance of x-ray examination in all "sprains" of the wrist is stressed, since the weakening effect of non-union resulting from improper care may cause serious dysfunction.

Q. B. CORAY, M.D.

**Unusual Pelvic Fracture.** J. E. Musgrove. *Canad. M. A. J.* 50: 446-447, May 1944.

A pelvic fracture is reported as unusual because of the solitary fracture line seen traversing the right inferior pubic ramus and the comparatively small degree of etiological trauma. This mishap occurred when a 40-year-old Canadian private, in good health and doing sedentary work, slipped on the ice and "did the splits." Although he fell with most of his weight on his left buttock, severe pain was experienced in the adductor region of the right thigh near the groin. A provisional diagnosis was made of strain of the right adductor longus muscle at its origin from the pubic bone. The pain persisted, however, in spite of bed rest and application of hot packs, and roentgenograms were then made. These revealed the fracture line across the pubic ramus, with two adjacent condensed lines interpreted as buckling of the cortex. Subsequent roentgen examinations showed satisfactory healing with good callus formation. The patient was discharged from the hospital after five weeks in bed and had excellent function with no pain after two more weeks.

This fracture was believed to be caused by the sudden, powerful traction of the adductor magnus. It was similar roentgenographically to the "march fractures" of the pelvis described by Nickerson (*Am. J. Surg.* 62: 154, 1943. *Abst. in Radiology* 42: 611, 1944).

LESTER M. J. FREEDMAN, M.D.

## THE GENITO-URINARY TRACT

**Bilateral Nephrolithiasis in Horseshoe Kidney.** Franklin Farman. *J. Urol.* 51: 447-455, May 1944.

A horseshoe kidney is more subject to complicated pathological states than is the normally formed kidney. Infection, calcuosis, neoplasm, abnormal position, and aberrant blood supply are frequently associated with these malformed kidneys.

While unilateral lithiasis is apparently one of the most frequently observed concomitant lesions in the malformed kidney, the relative rarity of bilateral calculi in horseshoe kidney may be due to the fact that usually one or the other side of a fused kidney has better ureteral drainage and, consequently, less chance of urinary stasis, infection, and stone deposition.

Surgery upon the malformed kidney is dangerous, due to excessive anomalously placed blood vessels. Except for this, indications for operation are similar to those influencing decisions in the presence of a normal kidney. At times, bilateral simultaneous operation has been performed, especially through the transperitoneal approach. However, the author prefers to operate upon the "bad" kidney first to relieve acute symptoms, reserving the "good" kidney for a more selective type of operation when infection and sepsis have decreased. Conservation of renal tissue is of the utmost importance, for though the total gross volume of parenchymal tissue may equal that of two normally functioning kidneys, usually their combined function is a great deal less, due to the almost universal finding of some degree of "nephritis" within the anomalous organ.

The author reports a case of bilateral nephrolithiasis in a horseshoe kidney. Operation was performed on one side at a time, with no attempt to divide the isthmus. Bilateral nephrostomy was undertaken after the stones were removed. The clinical result was excellent.

STUART P. BARDEN, M.D.

## PARASITES

**Calcification in the Guinea Worm.** J. S. Brocklebank. *Brit. J. Radiol.* 17: 163-164, May 1944.

Infestation with the guinea worm (*Dracunculus medinensis*), common in some parts of Africa and India, occurs through drinking contaminated water. The larvae make their way from the stomach to the subcutaneous tissues usually in the feet or lower legs, where the female matures to a length of 1 to 4 feet. A small blister appears on the skin from which the larvae are discharged. The worm can usually be seen and palpated. It may be demonstrated radiographically by the injection of an opaque medium. The worm after death may become calcified. It is commonly seen as a sharply defined linear opacity, 1 to 4 mm. in width, frequently segmented. The calcification may be limited to one or more segments.

SYDNEY J. HAWLEY, M.D.

## RADIOTHERAPY

### NEOPLASMS

**Treatment of Accessible Malignant Tumors with Short Distance Low Voltage Roentgen Rays.** D. Waldron Smithers. *Am. J. Roentgenol.* 51: 730-738, June 1944.

After briefly discussing the apparatus, limitations, and advantages of low-voltage short-distance roentgen therapy, the author describes the methods employed at the Royal Cancer Hospital (London). This method of treatment is limited to lesions that are directly accessible, for which it has certain advantages over radium, notably the high intensity of radiation, resulting in short treatment times, and low initial cost of the apparatus. Use is made of both the Siemens and Philips tubes. The former has a higher inherent filtration and the focal-skin distance is greater, but these factors are advantageous in some types of tumor. The author objects to the "caustic" method, whereby treatment is given at one sitting with a single massive dose. He prefers fractionation for most lesions.

For each patient a plan of treatment is outlined, with the intent to deliver an adequate tumor dose as evenly as possible to a volume that more than includes the limits of the tumor. When necessary, scale drawings are made and isodose curves applied. For the larger tumors, multiple fields are used, care being taken that there is no overlapping. When possible, two directly opposing fields are employed. This can be done in most cases of cancer of the lip, nose, ear, and anterior third of the tongue. In each case a dose is given which will result in a minimum tumor dose of 4,500-6,500 r within ten to fifteen days. The average daily dose per single field is 600 r.

The Siemens and Philips tubes have been well designed for intracavity therapy and are useful in the treatment of carcinoma of the cervix and in some intraoral tumors. The method has been used for the treatment of carcinoma of the urinary bladder after surgical exposure. Extension of this application may be expected in the future. L. W. PAUL, M.D.

**Treatment of Carcinoma of the Dorsum of the Hand.** P. D. Braddon. *M. J. Australia* 1: 368-370, April 22, 1944.

From the surgical and radiotherapeutic point of view, carcinomas of the dorsum of the hand are classed as (1) relatively early, (2) advanced, and (3) advanced, unsuitable for irradiation.

Relatively early carcinomas are almost invariably squamous-cell; in some thousands of cases only 6 basal-cell carcinomas have been encountered. The term "early" refers not to the duration of the growth, but to the stage of advancement. Lesions in this group, measuring up to a little over 2 cm. in diameter, are best treated by surgery.

Advanced carcinomas are those measuring over 2.5 cm. in diameter. During the last eight years the author has treated 200 cases of this type. Radium or radon needles or seeds should never be implanted. All of the lesions in this group, however large, have been treated by radon molds. The total dose delivered is 6,000 gamma roentgens over a period of ten to sixteen days. Routinely 3,000 gamma roentgens are delivered over a period of seven days, at the end of

which the radon is replaced by a fresh application to the mold (which is not removed) to give a further 3,000 r over the ensuing seven days. These patients are not kept in the hospital, but the hand, wrist, and forearm are splinted to ensure that the mold, often very large in area, does not move in the slightest degree. Filtration is that of radon needles, capillary, or seeds employed—namely 0.5 or 0.8 mm. of platinum equivalent. Excellent results have been obtained in all cases, with good function, regardless of the extent of the lesion, with not a single case of radionecrosis, recurrence, or metastasis.

The author treated with surgery three cases too extensive for treatment with the radon mold. One patient had axillary metastases and died, in spite of amputation of the hand and excision of the axillary nodes. Partial amputation was performed in the second case, and axillary nodes were excised but histologically these showed no malignant growth. The third patient had radionecrosis and recurrence following x-ray treatment elsewhere. The result of partial amputation in this case was disappointing, because of sloughing of the tissues and poor healing.

**Concentration Method of Radiotherapy for Cancer of the Mouth, Pharynx and Larynx: Report of Progress.** Max Cutler. *Am. J. Roentgenol.* 51:739-746, June 1944.

Further experiences with the so-called "concentration method" of radiotherapy for cancers of the mouth, pharynx and larynx (*J. A. M. A.* 117: 1607, 1941. *Abst. in Radiology* 38: 635, 1942) are reported. Five techniques have been employed since 1938 in an effort to determine the comparative value of roentgen rays and radium, the optimum voltage, optimum roentgen intensity, optimum daily and total doses, optimum treatment time, and the optimum number and size of fields. These are as follows.

(1) Telecurietherapy, with twelve treatment days, a single constant portal, and a total dose of 120,000 mg.-hr. This is used for lesions of the alveolar ridge and floor of the mouth in which the disease is entirely or mainly unilateral.

(2) Roentgen therapy, with twelve treatment days, two constant portals, and doses of 7,600 to 8,400 r. This is being used for lesions of the soft and hard palates.

(3) Roentgen therapy, with eleven treatment days, single diminishing portal, dose of 5,400 r. This is used in intrinsic carcinoma of the larynx when radiotherapy has been decided upon as the method of treatment.

(4) Roentgen therapy, interrupted method, with ten treatment days, two fields, diminishing portals, dose of 7,700 r. This technique is used in the more advanced cases of intrinsic carcinoma of the larynx, in which it is desired to know the radiosensitivity of the lesion. (See Cutler: *Arch. Otolaryng.* 39: 53, 1944. *Abst. in Radiology* 43: 315, 1944).

(5) Roentgen therapy, with eighteen treatment days, single diminishing portal, dose of 6,500 r. This is used in extrinsic carcinomas of the larynx and has been the most effective method so far observed for this type of lesion.

The basis of the method of concentration is the use of large daily doses over a comparatively short treatment period (ten to eighteen days). The total dose is

sufficient to produce an "epithelitis" and occasionally an epidermitis. The method has resulted in regression, disappearance, and apparent cures of lesions that had failed to respond to the divided dose technic. There is some evidence that gradually increasing the daily dose and decreasing the size of the field is of advantage.

The results in 290 cases treated between April 1938 and April 1943 are recorded in tabular form. Illustrative cases are included for each of the treatment technics described.

L. W. PAUL, M.D.

**Indications for and Effects of Irradiation of the Pituitary Gland: Symposium.** Edgar A. Kahn, A. C. Crooke, and J. F. Bromley. *Brit. J. Radiol.* 17: 133-139, May 1944.

This Symposium opens with a paper by Major Kahn of the U. S. Army Medical Corps. He presents the views of various authorities as to the irradiation of chromophobe adenomas of the pituitary. Of Cushing's large series (as reported by Henderson: *Brit. J. Surg.* 26: 811, 1939), only 10 patients received preoperative roentgen therapy, and in none of these was operation delayed more than a month. In only one was significant improvement observed following irradiation. Postoperative irradiation, however, was found to have a very favorable effect in decreasing the rapidity and percentage of recurrences. Sosman (personal communication to the writer) allows a six-month period to determine the effectiveness of the roentgen rays if the patient is not growing worse. He believes that satisfactory remissions will follow irradiation in about 50 per cent of cases. Dyke and Davidoff also recommended a trial of irradiation for chromophobe adenomas, to be followed by operation if necessary. Davidoff believes that 40 to 60 per cent of these tumors will respond favorably to roentgen therapy. Dott and Peet, on the other hand, regard the chromophobe adenomas as insensitive to radiation. Kahn's own opinion is that in comparatively early cases a fair trial should be given x-ray therapy. If vision is borderline or deteriorating when the patient is first seen, operation should not be delayed. Irradiation should always be done postoperatively.

Crooke opened his contribution to the Symposium with the statement that, while the effect of deep x-ray therapy upon the size of pituitary tumors is established, the effect on the output of pituitary hormones is questionable. Pituitary glands examined after tumor doses of 1,600 r have shown no cytological changes, though functional change may, of course, occur in the absence of cytological alterations. It is difficult to evaluate changes in secretory activity due to irradiation, since normally the pituitary varies in its output and there are no accurate methods of assay. A possible method is a study of carbohydrate metabolism. Since patients with acromegaly and basophilism commonly have an associated diabetes mellitus, they are particularly suitable for such a study, the alteration of insulin requirements after irradiation functioning as an index of its effectiveness. In a case of acromegaly reported here, however, the diabetic condition became steadily worse, in spite of a total tumor dose of 2,540 r, which would thus appear to be inadequate.

The fundamental pathology in basophilism is different. Here there is a hyaline change in the basophile cells of the anterior lobe. The disease is one of hyperfunction, and irradiation would thus be expected to relieve the symptoms. Reports in the literature, how-

ever, have not shown satisfactory results. In 2 recorded cases improvement was obtained by radon implantation, and Crooke presents an additional case which, though refractory to x-ray therapy, responded promptly to the insertion of radon seeds. In view of these results, he believes that x-rays could accomplish good results if sufficiently large doses could be administered without damage to the surrounding structures.

Bromley, whose paper concludes the Symposium, feels that the radiation therapist is often asked to do too much and often too little in the treatment of pituitary tumors: too much in the sense that to obtain cure requires very large doses, which are difficult and dangerous to apply; too little in the sense that he is not often enough called upon to relieve symptoms, which can be accomplished with smaller doses. The best results are obtained in eosinophilic adenomas, but even in chromophobe tumors, if they are diagnosed early, a trial of irradiation is justified.

There is a field of treatment of pituitary conditions apart from true tumors that merits further attention. There is, for example, a mild form of Cushing's syndrome—amenorrhea or dysmenorrhea, mental stolidity, a tendency to virilism, and a coarse dry skin—that responds promptly to x-ray therapy. The headaches associated with hypertrophy of the pituitary at the menopause can also be relieved by small doses of x-ray to the gland.

SYDNEY J. HAWLEY, M.D.

**Discussion on the Treatment of Carcinoma of the Esophagus.** Hermon Taylor, W. M. Levitt, M. Lederman, *et al.* *Proc. Roy. Soc. Med.* 37: 331-340, May 1944.

In this discussion on carcinoma of the esophagus, radiotherapy received due consideration.

Levitt referred to a series of 7 cases previously recorded (*Proc. Soc. Roy. Med.* 27: 368, 1934) in which a strip-field method of deep x-ray therapy had been followed by disappearance of the growth. A subsequent study of this group, however, showed 5 deaths as a result of pulmonary lesions attributable to the irradiation and 1 from recurrent carcinoma. The remaining patient died of cardiac failure, and autopsy showed a brown atrophy of the heart muscle which was believed to be a radiation effect.

In spite of improvements in technic, Levitt still finds it impossible to reproduce his earlier results without injury to the lungs. He has been most successful with growths of the upper third of the esophagus showing large fleshy fungations into the lumen, and he believes that "with suitable dosage and distribution of radiations to the esophagus, and disregarding the lung, a very remarkable percentage of primary regressions can be obtained." Irradiation is contraindicated in the presence of mediastinitis, pulmonary extension and secondary deposits, as well as in all cases involving the lower third of the esophagus.

Lederman discussed radium therapy. Tumors of the cervical esophagus, with or without pharyngeal involvement he considers suitable for telerradium therapy, provided they do not extend below the first thoracic vertebra. Mid-esophageal growths may be treated by radium bougie or radon implantation. Lederman regards the former method as preferable and outlines the technic. Guisez is said to have had excellent results with this procedure. Lederman, however, can report only one survival for as long as two and a half years in a series of 33 cases, but he regards

the palliative effects as of "incalculable value." He mentions a case treated by Mr. Lawrence Abel with a survival period of ten years and death at the end of that time from intercurrent disease. Cardio-esophageal tumors are unsuitable for treatment either by tele-radium or radium bougie, which cannot deliver an adequate dose to the gastric part of the neoplasm. Implantation of radium seeds has been attempted, but accurate distribution of the dose is difficult, and the method is recommended only as a last resort.

D. W. Smithers favored roentgen therapy over surgery and presented his own results. He had treated over 100 cases with x-rays, 80 of them more than two years earlier, and had seen no instance of fibrosis of the lung in spite of the fact that 20 of these patients had lived one year or longer. Three patients, in two of whom microscopic proof of carcinoma was obtained, were symptom-free more than five years after treatment. Of 32 patients who completed treatment prior to the war, 30 experienced marked relief of symptoms, and 11 had remained symptom-free for varying periods.

Various aspects of the subject were taken up by other participants in the discussion.

**Value of Surgery and X-Ray Treatments in Carcinoma of the Breast.** Roswell T. Pettit. *Illinois M. J.* 85: 244-247, May 1944.

Statistical reports on carcinoma of the breast show a conflict of opinion, often confusing, in the evaluation of the results of treatment. This is due in part to the wide variation in the course of the disease and in classification of operable and inoperable cases.

The author quotes the statistics of Lazarus-Barlow, showing a 12 per cent five-year survival rate in 651 untreated cases of carcinoma of the breast, for use as a base line in evaluating results of treatment. In 10,000 cases treated surgically in 23 widely distributed clinics, the five-year survival reported varies from 16 to 52 per cent with an average of about 29 per cent. This is definite evidence of the value of surgical treatment. The wide variation in the percentages of survival may be due largely to differences in selection of cases for operation.

Operability depends upon the stage of the disease, especially the presence or absence of axillary involvement. The five-year survival reported in cases without involvement of axillary nodes varies from 61 to 74.2 per cent.

Irradiation followed by radical amputation has been preferred by many. Statistical reports on pre-operative irradiation, however, have been somewhat disappointing, and it has the disadvantage of delaying surgery several weeks. The results reported are slightly better than by surgery alone. Irradiation following radical mastectomy has shown better results. Adair reports 76.8 per cent five-year survivals in 95 cases without axillary involvement, and 41.8 per cent in 177 cases with extension to the axilla (*J. A. M. A.* 121: 553, 1943. *Abst. in Radiology* 41: 311, 1943). Since it has been shown by serial sections that most cases of carcinoma of the breast have axillary metastases, even if not palpable, postoperative irradiation is advocated for all cases. It is often overlooked that technic, skill, diligence, and good equipment are as important in the application of x-ray therapy as in the surgical treatment.

The author reports 149 cases of carcinoma of the breast treated postoperatively by irradiation with a

five-year survival of 58.3 per cent. The presence or absence of axillary metastases was not determined in all cases, but the majority of patients had axillary involvement.

X-ray therapy properly administered in sufficient dosage is an extremely valuable adjunct to surgery. The x-ray procedure is not well standardized, but with improvements that have been made and are being made it is reasonable to believe that five-year results in patients now being treated will be better than those previously obtained.

H. H. WRIGHT, M.D.

**Medical Progress. Gynecology: Carcinoma of the Cervix.** Joe V. Meigs. *New England J. Med.* 230: 577-582, 607-613, May 11 and May 18, 1944.

This is a rather long but excellent discussion of carcinoma of the cervix. Irradiation has been of great help in treating cervical cancer, the percentage of cure being about the same in all the large collections of statistics. Since there seems to be a limit to the cure and salvage by irradiation, the author advocates radical operative procedures with removal of cervix, uterus, tubes and ovaries, and the iliac lymph nodes. With experience, the operative mortality has decreased.

Many good points are made. It is suggested that the radiologist be given a freer hand in determining the method and amount of treatment. Many cancers of the cervix could be prevented by total hysterectomy. The Schiller test, colposcopy, and the newly advocated stained vaginal smear are all good procedures and should be used. Biopsy is still the best means of diagnosis and should be employed oftener and earlier. It is possible to take a specimen from a carcinoma of the cervix and not obtain malignant tissue. With the Schiller stain, the area for biopsy is well defined.

Classification according to the League of Nations formula is being more widely accepted and practised, although that of Schmitz or the American College of Surgeons is probably more convenient. The microscopic grading of tumors is not of great advantage either in treatment or prognosis.

Cancer of the cervical stump would not occur if every hysterectomy were a total hysterectomy.

A good discussion of cervical cancer in pregnancy is included.

JOHN B. McANENY, M.D.

**Carcinoma of the Bladder: An Improved Technique for the Cystoscopic Implantation of Radium Element.** Thomas D. Moore. *J. Urol.* 51: 496-504, May 1944.

In the past, treatment of infiltrating carcinoma of the bladder has been unsatisfactory, except for those series in which radium or radon therapy was included in the management.

The author, in 1938, first advocated a method of cystoscopic introduction of radium needles, which were left in place for twenty-four to seventy-two hours and then removed cystoscopically. This procedure is best suited for lesions of low-grade malignancy and occasional early cases of grade III and IV tumors. It is especially well adapted to aged patients because of the relatively low morbidity. The method is restricted to lesions accessible to direct cystoscopic view, namely, the trigone, lateral base, posterior wall, and posterior part of the lateral walls. It cannot be used for growths involving the dome, anterior wall, and anterior part of the lateral walls.

The advantages of radium needles over radon seeds are twofold. First, there is no foreign body left in a region which is subject to infection. In the second place, it is cheaper to use radium needles. The author's method is no more difficult than the implantation of radon seeds.

A cystogram is first made in order to determine the extent of infiltration. Then, under low spinal or pentothal sodium anesthesia, the Braasch direct-vision cystoscope is introduced and the lesion is electrocoagulated if sessile in type. Radium needles containing 1, 3, or 5 mg. and measuring 10 to 17 mm. in length are inserted into the lesion 1.5 cm. apart. This is accomplished by means of the author's special radium needle introducer. In men, the needles are identified by lead shot, but in women the silk threads are brought out through the urethra. The cystoscope is removed and a 75 c.c. Foley catheter is inserted. This is distended with 120 c.c. of sterile water to protect the opposing wall of the bladder and prevent accidental loss of the radium. Bladder irrigations are carried out through the catheter.

After forty-eight to seventy-two hours the cystoscope is reintroduced in male patients and the needles are removed by picking up the lead shot with a Braasch specimen forceps. In women, the catheter is removed and the needles are withdrawn by traction on the silk threads.

The author discusses the question of biopsy. He is convinced that this should be done routinely at the first cystoscopy.

In 11 of 96 cases in the author's files, this method was used (in 7 women and 4 men). All the lesions were grade II or III. Six patients are alive from one month to four and a half years. Five are dead after living six months to six years.

JOSEPH SELMAN, M.D.

**Cancer of the Female Urethra.** W. G. Cusaden. *M. J. Australia* 1: 487-489, May 27, 1944.

Fourteen cases of urethral cancer in women are presented. The average age of the patients was fifty-two years. Of the 14 patients, 6 are well at present, and one, after living twelve years, cannot be traced. Hemorrhage was the most consistent and in many cases the only symptom. Difficulty in micturition occurred only in advanced cases. Pain was a late symptom. Thirteen of the lesions were epitheliomata; one was an adenocarcinoma.

With slight variation, the same dosage and technique were used in all cases. Gold needles 2.5 cm. in length, containing 5 mc. of radon, screened by 0.8 mm. platinum, were inserted so that the treated tissue extended between concentric cylinders 7.5 and 17.5 mm. in diameter and 2.5 cm. in length. The needles were left in place for eight days. The average minimum dose around the outside of the treated tissue was 19,000 r, while the maximum dose was approximately 40,000 r 1.0 mm. away from the surface of the needle.

Some pain and frequency of micturition followed treatment, but usually subsided in six to eight weeks. Abundant fluids and citrate of potash were given during this period. Sloughing was not serious except in one case, in which two lots of irradiation were given. Radon in vaseline was used once a week in this case (eight hours) and was thought to have helped in healing the condition. With this single exception, stricture was not a serious complication.

**Osteogenic Osteolytic Sarcoma of the Os Pubis.** Sidney T. Friedman. *Am. J. Surg.* 64: 248-253, May 1944.

A case of osteogenic osteolytic sarcoma of the os pubis is reported, in which the only treatment possible was biopsy followed by roentgen irradiation. The patient lived approximately three and a half years after the institution of treatment.

**Hemangioblastoma of the Medulla—Lindau's Disease: Response to Radiation Therapy.** Mervyn H. Hirschfeld. *J. Nerv. & Ment. Dis.* 99: 656-659, May 1944.

No record of any attempted treatment for hemangioblastoma of the medulla or spinal cord could be found in the literature by the author. In the case described radiation therapy was attended by surprisingly good results.

This patient was a 21-year-old male whose chief complaint on admission was dysphagia. In the previous three years, he had gradually lost the sight of his left eye due to hemangioblastoma of the retina (von Hippel's disease) and glaucoma. The right eye was normal except for slight nystagmus on upward and lateral gaze. The left facial muscles contracted and relaxed more slowly than the right, but no definite paralysis was noted. Speech was somewhat labored due to accumulation of saliva in the throat. Numbness and tingling were present in the left upper and lower extremities but the patient could identify objects through tactile sensation and there was no alteration of temperature sense. Electroencephalography showed changes indicating a lesion in the right parietal and posterior temporal region. A pneumoencephalogram was normal but was followed by a severe reaction and complete inability to swallow, which lasted for forty-eight hours. The absence of definite cerebellar signs and the prominence of hiccups and dysphagia indicated that the major lesion was in the medulla.

Since operation was inadvisable, radiation therapy was administered over the occiput and upper cervical spine through right and left lateral portals. A total of 1,475 r, measured in air, was delivered in 22 sessions in 26 days (200 kv. constant potential, total filtration of 0.75 mm. Cu plus 2.0 mm. Al, 50 cm. target-skin distance, with an output of 53 r per minute). The calculated mid-line tumor dose was 2,160 r. The patient became worse during treatment, being confined to bed because of instability of his legs. Immobility of the pharynx and upper esophagus developed, being demonstrable by fluoroscopy. One week after the termination of treatment, there was marked decrease of salivation with rapid progressive improvement of symptoms. Four months after treatment, tingling in the ulnar three fingers of the left hand was the sole symptom and slow reaction of the left facial musculature was the only abnormal neurologic finding. Enucleation of the left eye was advised but was refused. Because of the usual multiplicity of lesions in this condition and their variable rate of development the author does not regard this case as closed.

LESTER M. J. FRIEDMAN, M.D.

**Hemangioma of the Testis.** A. H. Kleiman. *J. Urol.* 51: 548-549, May 1944.

The author reports a case of testicular tumor in a 51-year-old white carpenter, preoperatively diagnosed



as malignant but found histologically to be benign. The chief complaint was slow enlargement of the left scrotal contents, without tenderness but producing a dragging sensation of the scrotum. The mass was first noticed a year before admission.

The left testis was three times its normal size and only slightly sensitive to pressure. The vas deferens and epididymis were normal, as were results of all laboratory studies. The patient received a total of 5,300 r to the mass between Aug. 27 and Sept. 28, 1940, which was well tolerated and caused the mass to shrink to less than one-half its former size. Orchiectomy was performed three weeks later.

On gross examination, the split left testis was found to contain in its center a dark red nodule 2 cm. in diameter. Microscopically, it was seen to be surrounded by a thick wall of fibrous tissue, while its substance was composed of anastomosing capillaries, venules, and small arteries distended with erythrocytes. There was a delicate fibrous tissue stroma between the blood spaces, and the surrounding seminiferous tubules were atrophic. The pathologic diagnosis was hemangioma cavernosum. The postoperative course was uneventful.

Hemangioma of the testis is a rare condition. Study of several sections of the tumor has failed to reveal any malignant process. N. P. SALNER, M.D.

## EXPERIMENTAL STUDIES

**Experimental Hypoproteinemia and Edema. Studies of Intestinal Absorption and Intestinal Roentgenologic Characteristics.** Argyl J. Beams, Alfred H. Free, and Jack R. Leonards. *Arch. Int. Med.* 73: 397-402, May 1944.

Hypoproteinemia with edema was produced in 5 dogs by means of plasmapheresis. The intestinal absorption of galactose and aminoacetic acid was studied by improved tolerance tests in these animals and was found to be unaffected to any significant degree.

Roentgen studies of the gastro-intestinal tract following the administration of barium showed no alteration in gastric emptying and intestinal motility as a result of the hypoproteinemia and edema. In some of the films of the small intestine during edema there were moderate clumping of the barium and segmentation. These phenomena were also noted in the studies on normal animals, although they occurred less frequently.

Studies of plasma volume and available (thiocyanate) fluid volume indicated that during edema the plasma volume is not significantly altered but that the available (thiocyanate) fluid volume is noticeably increased.

The rate of metabolism of galactose and aminoacetic acid was not altered by hypoproteinemia and edema.

**Area Factor in Roentgen Irradiation.** H. C. Goldberg. *Arch. Dermat. & Syph.* 49: 346-347, May 1944.

In a series of experiments the author has measured the amount of irradiation necessary to cause an erythema in areas having diameters from 1 to 10 cm. Using 120 kv., 6 ma., 10 cm. target-skin distance, and no filter, which gives a half-value layer of 1.9 mm. Al, he has in chart form given the number of units necessary for an erythema dose.

It was found that 3,060 r were needed in treating an area 1 mm. in diameter in order to get an erythema effect on the skin, whereas 510 r were sufficient to get the same effect on an area 10 mm. in diameter. A series of tests was made to determine the area factor in relation to dosage, the number of skin units necessary to cause an erythema. JOSEPH T. DANZER, M.D.

**Effect of Iodized Poppyseed Oil and Iodine-Chlorine in Peanut Oil in the Subarachnoid Space of Animals.** Edwin Boldrey and Robert B. Aird. *J. Nerv. & Ment. Dis.* 99: 521-533, May 1944.

Search for a substitute radiopaque oil was prompted by the disappearance from the market of 40 per cent iodized poppyseed oil (lipiodol) following the fall of France. Lipoiodine (60 per cent solution of di-

iodobradic acid in sesame oil) and iodochlorol (27 per cent iodine, 7.5 per cent chlorine, in peanut oil) were considered for study, but since the former proved the more irritating in preliminary studies, it was discarded.

Six parallel experiments were attempted on large dogs, averaging over 18 kg. in weight. Cisternal fluid was removed from the animals under local anesthesia and 2 c.c. of lipiodol or of iodochlorol were injected into the subarachnoid space. Spinal fluid was removed at intervals for cell counts and for Pandy reactions. Some animals were autopsied within a week and others within three months following one injection. Four dogs had a repeat injection one week following the first, 2 of these being autopsied 4 days later and the remaining 2 three months later. A third group was similarly studied after single injections of the oils combined with 2 c.c. of blood.

The reaction of the animals to iodochlorol was comparable to and generally slightly less in degree than the reaction to lipiodol. The irritative phenomena were found to be definitely increased in the animals that received the blood injection. The total cell counts of the spinal fluid were elevated, reaching a peak in twenty-four to forty-eight hours following the oil injection and gradually decreasing over a four-week period. The repeat injection prompted a secondary rise in the count. The differential count showed a predominance of polymorphonuclears with a shift to a lymphocytic reaction during the first week after injection of iodochlorol. Pandy responses were all positive.

Microscopic studies showed early changes in the meninges to be minimal in degree and extent. These were somewhat more marked after a repeated dose of oil. The addition of blood to the opaque media increased the irritating effect from the very beginning. Adjacent ganglion cells showed changes in their nuclei and tigroid substances in many instances. Advanced proliferative and fibrotic changes in the meninges were noted in the animals sacrificed late. The oils were walled-off in a mesh-work of cysts and fibers in the subarachnoid space, extending even to the caudal sac in some of the dogs. Less fibroblastic and collagenous response was evoked by iodochlorol than by lipiodol. This was also true of the chronic inflammatory cell reaction. No abnormalities were noted in the ganglion cells in this "late" group, indicating that the changes noted in the "early" groups were reversible.

The authors believe that early removal of these oils from the subarachnoid space is highly desirable.

LESTER M. J. FREEDMAN, M.D.



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# RADIOLOGY

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## The Roentgen Appearance of Lobar and Segmental Collapse of the Lung: A Preliminary Report<sup>1</sup>

LAURENCE L. ROBBINS, M.D., and CLAYTON H. HALE, M.D.

Boston, Mass.

SOME DEGREE of collapse or atelectasis of the lung, a lobe, or a segment of a lobe, is frequently associated with certain disease processes in the chest, such as foreign body, tumor, bronchiectasis, and tuberculosis. Inasmuch as collapse is often confused with other lesions, in which the treatment differs, as pneumonia and infarct, its recognition is important. In this paper we shall present certain roentgenologic findings in collapse which may be the first to be observed and may be of more importance in diagnosis than the commonly accepted signs—elevation of the diaphragm, shift of the mediastinum, narrowing of the rib spaces, and demonstration of the shadow of the collapsed lobe.

We have restricted the use of the word "collapse" to a decrease in the size of a lobe or a part of a lobe, and of the word "atelectasis" to airlessness.

From a total of 70,000 chest examinations made at the Massachusetts General Hospital during the last six years, we reviewed in detail 1,000 that led to a diagnosis of tumor, bronchiectasis, or foreign body, as well as a number of cases of tuberculosis associated with definite collapse. After discarding the cases for which there

were not adequate films in both postero-anterior and lateral projections, there remained approximately 500 cases in which at least one lobe was less than two-thirds of its normal size. The findings presented in this report are based on this series of 500 cases.

### TECHNIC

The examination of patients with suspected collapse should begin with fluoroscopy, which will determine the dynamics within the chest and indicate which films will best demonstrate the lesion. In the majority of instances, the routine postero-anterior, the lateral, and the Potter-Bucky or grid projections will give the necessary information. In certain cases, particularly those with bilateral lesions, oblique views will provide additional data. Many cases will require bronchography, and a few will call for laminagraphy for confirmation of a diagnosis.

### NORMAL CHESTS

It has been our impression for some time that roentgenologic localization of the fissures of the lung is possible by the demonstration of thin lines of increased density, which we have called septa. The term "septum" rather than fissure has been used because a pulmonary fissure is a potential space, which is not demonstrable

<sup>1</sup> From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.



Fig. 1. Case 1 (J. P., U-443473): Collapse of the left lower lobe in a 63-year-old man, complaining of weakness, fatigue, weight loss, dyspnea, night sweats, and cough productive of phlegm with bright red blood, of six months' duration.

*Postero-Anterior Roentgenogram:* Collapse is not well seen except for the increased density lateral to the apex of the heart. The greater portion of this is due to a tumor. The hilus is not displaced, which is atypical. Emphysema of the left upper lobe, though present, is not striking because of an equal degree of emphysema on the right. The mediastinum is displaced slightly to the left. The left diaphragm is not elevated but is partially obscured.

*Lateral Roentgenogram:* The shadow of the lower lobe is clearly defined and within it the tumor is well demarcated. The left upper lobe rests on the anterior half of the diaphragm; the posterior half is not seen because of the collapse and tumor. The location of the left fissure is demonstrated by the edge of the collapsed lobe, which lies posterior to the clearly demonstrated septa on the right. In this projection, the tumor is demonstrated as lying posteriorly in the lower lobe; it is of sufficient size to prevent depression of the hilus.

*Bronchoscopy:* Evidence of chronic bronchiectasis; no tumor seen.

*Thoracotomy:* Lower lobe hard and non-aerated. Tumor tissue invading pleura. Pneumonectomy impossible.

*Histopathology:* Epidermoid carcinoma, grade III.

by x-ray, whereas the two pleural surfaces, which are in apposition, cast a well defined shadow. In order to substantiate this impression, and to determine the normal variation and location of the septa, 150 patients who had no pulmonary complaints were examined by means of both postero-anterior and lateral roentgenograms. In the majority of cases, the location of the minor fissure on the right is demonstrable on the postero-anterior projection, while in the lateral view, the major septa, or fissures, are also shown. The major fissures in general run obliquely downward and forward from approximately the fifth dorsal vertebra to the anterior portion of the diaphragm, varying from a point at the

anterior chest wall to 6 cm. from it. As a rule, they are straight or gently curved lines as projected on the lateral roentgenogram. The minor fissure on the right, visible in both the postero-anterior and lateral projections, varies in position from the third to the fifth rib anteriorly. Variations from the normal position or curve of the septa may be indicative of collapse.

The study of the normal chest was important also in confirming a second impression, that is, that variation from the normal position of the hilar shadows frequently indicates different degrees of collapse. Anatomically the hili are at about the same levels. On the roentgenogram, however, the left hilus usually appears



Fig. 2. Case 2 (E. G., U-427028): Partial collapse of the left lower lobe in a 41-year-old woman, with hemoptysis and pain in the left chest, of two months' duration.

*Postero-Anterior Roentgenogram:* Atelectatic segments of the lower lobe are seen as areas of increased density behind the heart on the left. The hilus is slightly low. Emphysema of the left upper lobe, more marked in the lingula, is due to spatial rearrangement. The mediastinum is in normal position. The left diaphragm is slightly elevated.

*Lateral Roentgenogram:* The triangular shadow of increased density represents complete collapse of all the segments of the lower lobe except for the dorsal division. The left upper lobe rests on the anterior two-thirds of the left diaphragm. The posterior one-third is obscured by the collapsed segments. The normal septum is not seen. The unimpaired aeration of the dorsal segment probably prevents depression of the left hilus that is usually seen with collapse of this lobe.

*Bronchoscopy:* Thick, grayish-white mucoid plug obstructs left lower lobe bronchus just distal to orifice of dorsal division. No tumor seen.

slightly higher than the right, since the right main bronchus, which forms the upper margin of the right hilus, is not so clearly visualized as the left pulmonary artery, which forms the upper margin of the left hilar shadow. This study has strengthened our conviction that, although the commonly accepted signs of collapse are of definite value, the position and appearance of the septa and hili are of more importance and may be the first signs suggesting the diagnosis.

#### ROENTGENOLOGIC SIGNS OF COLLAPSE

*Lower Lobes (Figs. 1-3):* In general, when a lower lobe collapses, it tends to lie

posteriorly and medially against the spine. The hilus is low in position and the adjacent lobe (or lobes) shows compensatory emphysema. In the lateral projection, the anterior edge of the collapsed lobe may be readily visualized, thus indicating that the septum is displaced posteriorly. The shadow of the diaphragm in the area of collapse is lost, and the markings within the collapsed lobe are close together, showing a tendency to curve toward the hilar area with the convexity of the curve anteriorly. It is this collapsed lobe and the increased markings which are often described as the triangular shadow in bronchiectasis.



Fig. 3. Case 3 (K. T., U-242187): Collapse of the right lower lobe in a 44-year-old man, with cough and weight loss for two years.

*Postero-Anterior Roentgenogram:* The shadow of increased density obscuring the right border of the heart and the medial half of the right diaphragm represents a tumor and the collapsed right lower lobe. The right hilus is moderately low in position.

*Lateral Roentgenogram:* The tumor and collapsed right lower lobe are shown occupying the postero-inferior portion of the right chest, obscuring the posterior half of the right diaphragm. The right upper and middle lobes show moderate emphysema. The minor septum on the right extends to the posterior chest wall. The major septum on the left is clearly seen and is normal in position.

*Right Pneumonectomy:* Right lower lobe found quite small, rounded, and very dense and hard.

*Surgical Specimen:* Lower lobe bronchus obstructed by tumor. Lower lobe very firm, moderately collapsed, and completely consolidated.

*Histopathology:* Epidermoid carcinoma, grade III.

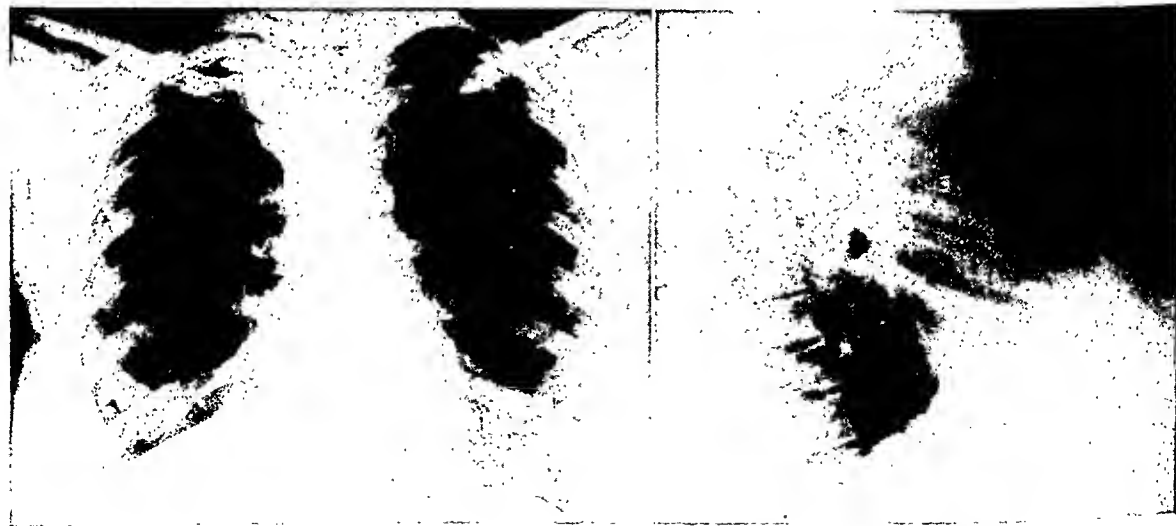


Fig. 4. (M. P., U-455051): Collapse of the right upper lobe in a 26-year-old woman with known pulmonary tuberculosis for three years.

*Postero-Anterior Roentgenogram:* The shadow of increased density in the right apex represents the collapsed right upper lobe. The right hilus is elevated. The emphysematous right lower and middle lobes occupy the greater portion of the right chest. The trachea is deviated to the right. The right diaphragm is slightly elevated.

*Lateral Roentgenogram:* The collapsed right upper lobe is seen in the anterior portion of the chest. The right major septum is clearly visualized and is displaced upward and anteriorly.

*Right Upper and Middle Lobectomy.* Right upper lobe composed about one-third of the specimen, was markedly decreased in size, and contained numerous tubercles.

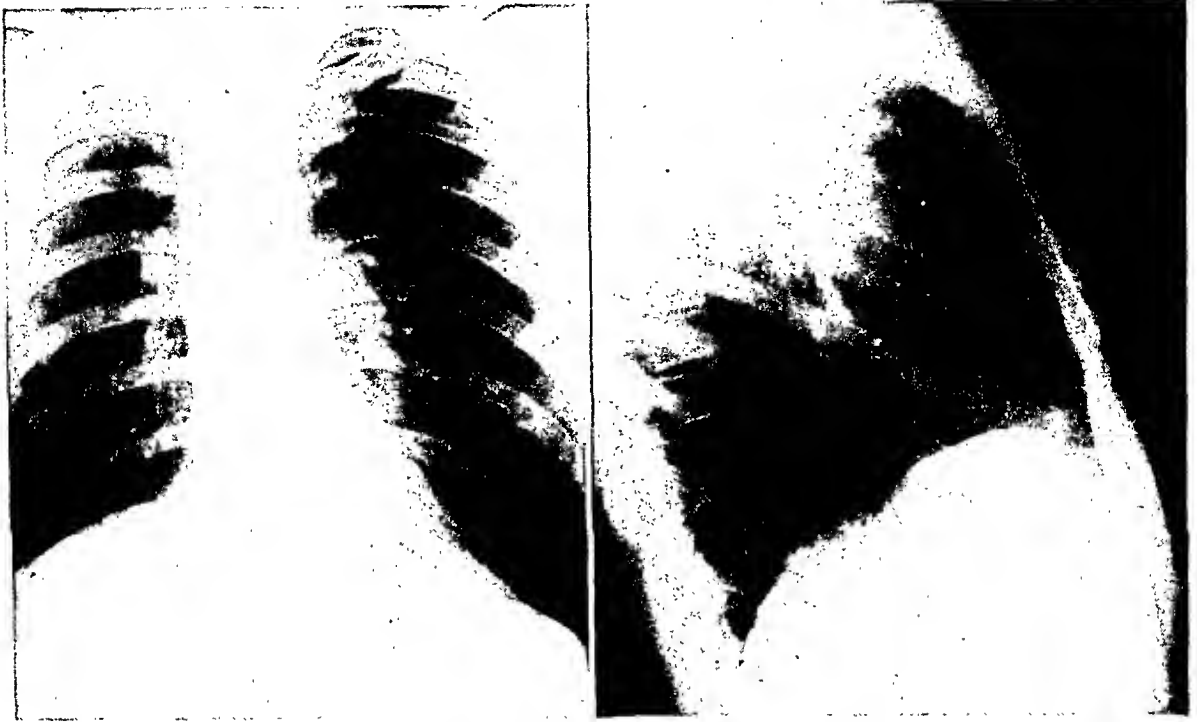


Fig. 5. Case 5 (J. N., U-448275): Collapse of the right upper lobe in a 42-year-old man with chronic cough of four and a half months' duration. Onset followed Type 2 pneumonia. Slight general malaise; no hemoptysis or expectoration.

*Postero-Anterior Roentgenogram:* There is increased density in the right apical area, with fairly good aeration in the lower portion of the right upper lobe. The right hilus is moderately elevated. The minor septum is slightly higher than usual. The trachea is deviated to the right.

*Lateral Roentgenogram:* The collapsed area is not well visualized because it is so high in the chest. The major and minor septa are clearly seen and are displaced upward and anteriorly. The posterior portion of the left major septum lies in its normal position.

*Right Upper Lobectomy:* Atelectatic apical segment of right upper lobe.

*Histopathology:* Chronic pneumonitis and slight bronchiectasis.

*Upper Lobes (Figs. 4-7):* Collapse of the upper lobes more or less reverses the appearance of collapse of the lower lobes. The upper lobe tends to collapse anteriorly and medially against the anterior chest wall and to obliterate the space that, in the lateral view, is usually seen between the sternum and the ascending aorta. A collapsed upper lobe may become so small that in routine postero-anterior or stereoscopic views it may be overlooked, its appearance being misinterpreted as a slight widening of the superior mediastinum. The hilar shadow moves upward and is indistinct in outline, particularly the upper margin. Adjacent compensatory emphysema is apparent. In certain instances, the entire lung may appear to be aerated, but surgical or autopsy data may reveal that the apparent aeration was

due to an emphysematous lower lobe, or lower and middle lobes. In the lateral view, the posterior margin of the collapsed lobe is seen and indicates the position of the septum. It usually forms a smooth curve with the convexity toward the anterior chest wall. The markings are not as well visualized in the upper lobes as in the lower lobes, which is probably due to the fact that bronchiectasis with resulting rigidity of the bronchial walls is less frequent in the upper lobes, and consequently the bronchi also are collapsed rather than air-containing. The mediastinum may be displaced, and more particularly the trachea may be deviated, toward the side of the lesion.

*Middle Lobe (Fig. 8):* The middle lobe frequently shows segmental collapse, and when this occurs the two segments may be





Fig. 6. Case 6 (J. J., U-388860): Collapse of the left upper lobe in a 62-year-old man with dyspnea and hemoptysis of one year's duration. For details of case see opposite page.

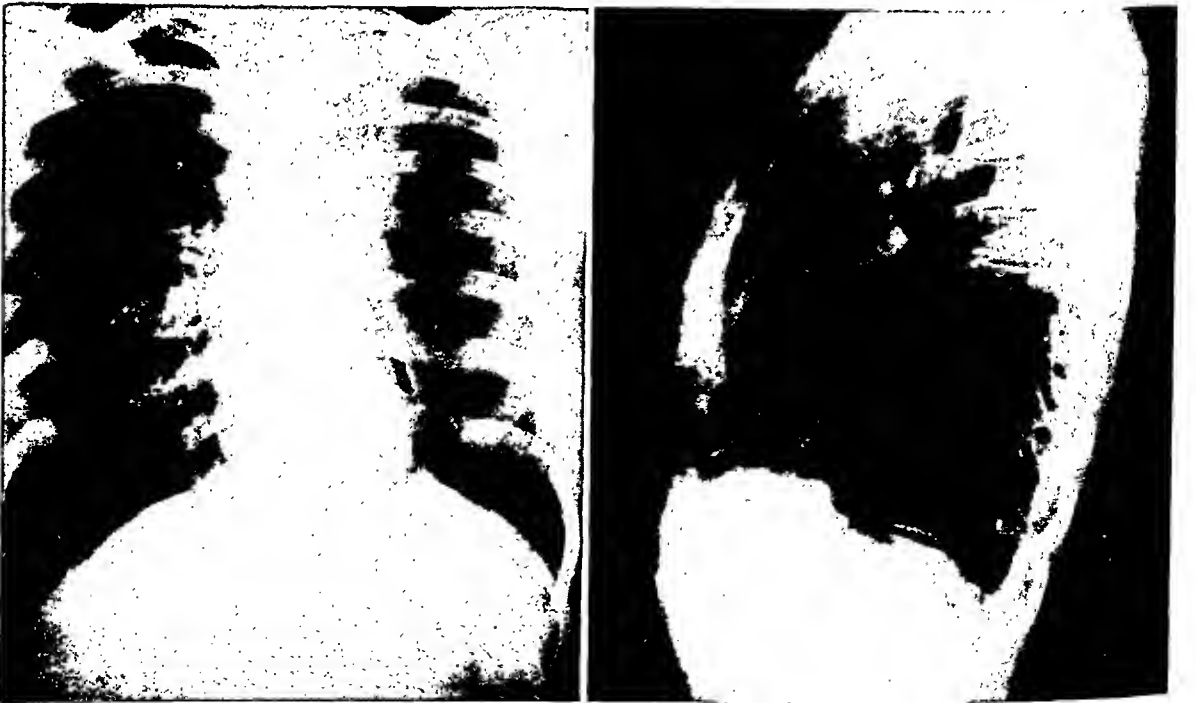


Fig. 7. Case 7 (D. G., U-265728): Collapse of the left upper lobe in a 27-year-old woman with a history of repeated bouts of sinusitis and upper respiratory tract infection since childhood and cough and left chest pain for two weeks. For details of case see opposite page.

Case 6: Collapse of left upper lobe, shown in Figure 6 on opposite page.

*Postero-Anterior Roentgenogram:* The increased density in the left hilar region and the obscuring of the left mediastinal shadow are due to a tumor and the collapsed upper lobe. The air in the left chest is within the left lower lobe. The hilus is not well visualized. There is an increase in the linear markings of the right upper lobe, with some decrease in its size. The left diaphragm is slightly elevated.

*Lateral Roentgenogram:* The collapsed left upper lobe and the tumor within it are clearly seen lying against the anterior chest wall. The left lower lobe is emphysematous, extending to the top of the left chest and anteriorly to outline the posterior border of the collapsed left upper lobe. There are a few dilated bronchi in the left lower lobe as evidenced by some bronchiectasis in this lobe.

*Bronchoscopy:* The orifice of the left upper lobe bronchus was not seen because of a round, nodular, slightly irregular mass almost completely obstructing the left main bronchus.

*Thoracotomy:* Inoperable, due to enlarged mediastinal nodes.

*Histopathology:* Epidermoid carcinoma, grade III.

Case 7: Collapse of left upper lobe, shown in Figure 7 on opposite page.

*Postero-Anterior Roentgenogram:* The area of density in the medial portion of the left upper lung field represents the collapsed left upper lobe. A few dilated bronchi are seen within the shadow. All of the air seen in the left lung field is in the lower lobe. The hilus is displaced upward; the trachea is deviated to the left. The left diaphragm is slightly elevated.

*Lateral Roentgenogram:* This is the typical appearance of collapse of the left upper lobe. The posterior edge of the left upper lobe is clearly defined, and it is seen that the lobe is collapsed anteriorly against the chest wall. The emphysematous lower lobe occupies the greater portion of the left side of the chest. The septa of the right lung are well visualized.

*Left Upper Lobectomy:* The upper lobe was completely collapsed.

*Histopathology:* Bronchiectasis.

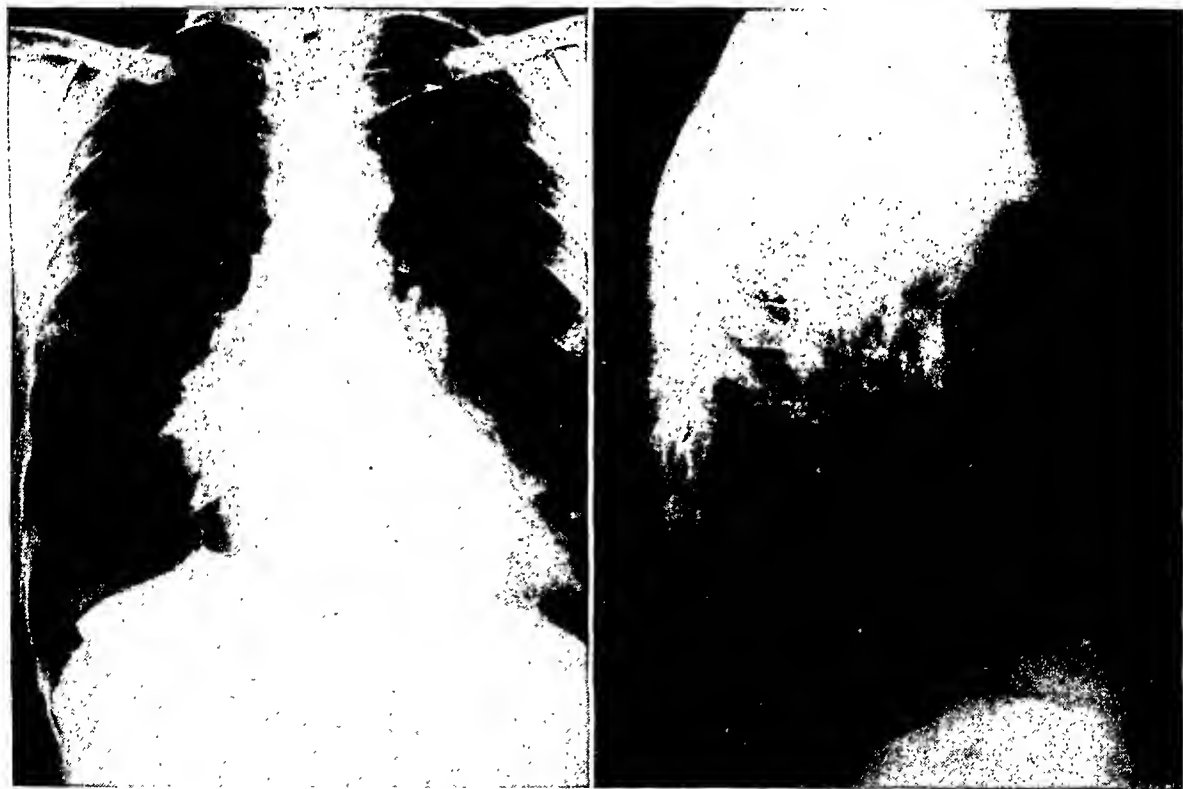


Fig. 8. Case 8 (E. P., U-405062): Collapse of the right middle lobe in a 53-year-old woman with a productive cough for seven months and a history of hemoptysis two and a half months and four years prior to admission.

*Postero-Anterior Roentgenogram:* The right border of the heart is obscured by the atelectatic right middle lobe. The right hilus is only slightly low. The normal minor septum is never seen in complete collapse.

*Lateral Roentgenogram:* A triangular shadow of increased density is seen in a much smaller area than is usually occupied by the middle lobe. Slight compensatory emphysema of the upper and lower lobes accommodates for the collapsed middle lobe. Incidentally an area of bronchiectasis is seen in the postero-medial segment of the left lower lobe.

*Bronchoscopy:* Middle lobe orifice narrowed and completely plugged by thick white-gray secretion which cannot be expectorated by coughing.

demonstrated. In complete collapse, the middle lobe tends to flatten and lies against the right border of the heart, thus obscuring its shadow. In certain cases, collapse of the anteromedial segment of the right lower lobe may obscure the right heart border. The lateral view, however, will enable one to differentiate between the two, since it will show a collapsed anteromedial segment to lie posteriorly, while a collapsed middle lobe will lie anteriorly in the usual location of the right middle lobe. Occasionally an emphysematous anteromedial segment of a right lower lobe will permit visualization of the right border of the heart even when the right middle lobe is collapsed. This is made possible by the emphysematous segment extending far enough anteriorly to outline the posterior portion of the right heart, which normally lies next to the right middle lobe. In many cases the only sign in the postero-anterior projection of the collapsed middle lobe is loss of definition of the right border of the heart, and it is imperative to use a lateral projection to demonstrate clearly the shape as well as the degree of collapse. A lordotic view will confirm the size and shape of the collapsed right middle lobe. When a segment only is involved, the septum between the normal segment and the adjacent lobe may be seen readily. When the entire lobe is collapsed, normal septa

are not demonstrable. As a rule, collapse of the middle lobe produces very little change in the position of the hilus, mediastinum, or diaphragm.

#### CONCLUSIONS

1. This is a preliminary report of a study of the roentgenologic appearance of collapse of the lung and its subdivisions.
2. A technic has been described briefly by which collapse may be best demonstrated, requiring in the majority of cases but three roentgenograms following an initial fluoroscopy.
3. The appearance of the septa and the hilar shadows is of more importance than the usual diagnostic criteria of collapse, although the latter will also be of use.
4. The appearance of collapse of the various lobes has been described briefly.

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#### DISCUSSION

C. C. Birkelo (Detroit, Mich.): I want to compliment Drs. Robbins and Hale on the splendid paper they have presented, showing a way of definitely identifying the various lobes of each lung. Because of recent developments in thoracic surgery, lobectomies and pneumonectomies for the amputation of tuberculous lesions and carcinoma of the lung are becoming quite common. It is therefore important to show location of interlobar septa and to localize the disease.



# Roentgenographic Changes in Bone Infections Treated with Penicillin<sup>1</sup>

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THE RECENT generalized use of penicillin has stimulated interest in the treatment of infections of all types with this biological agent. We have had the opportunity of using penicillin in approximately 25 cases of bone infection, both

occurring in bone infections susceptible to treatment with penicillin. Certain of these cases represent old chronic infections, and in these the response was by no means dramatic, although in the majority there was a decrease in drainage, with improve-

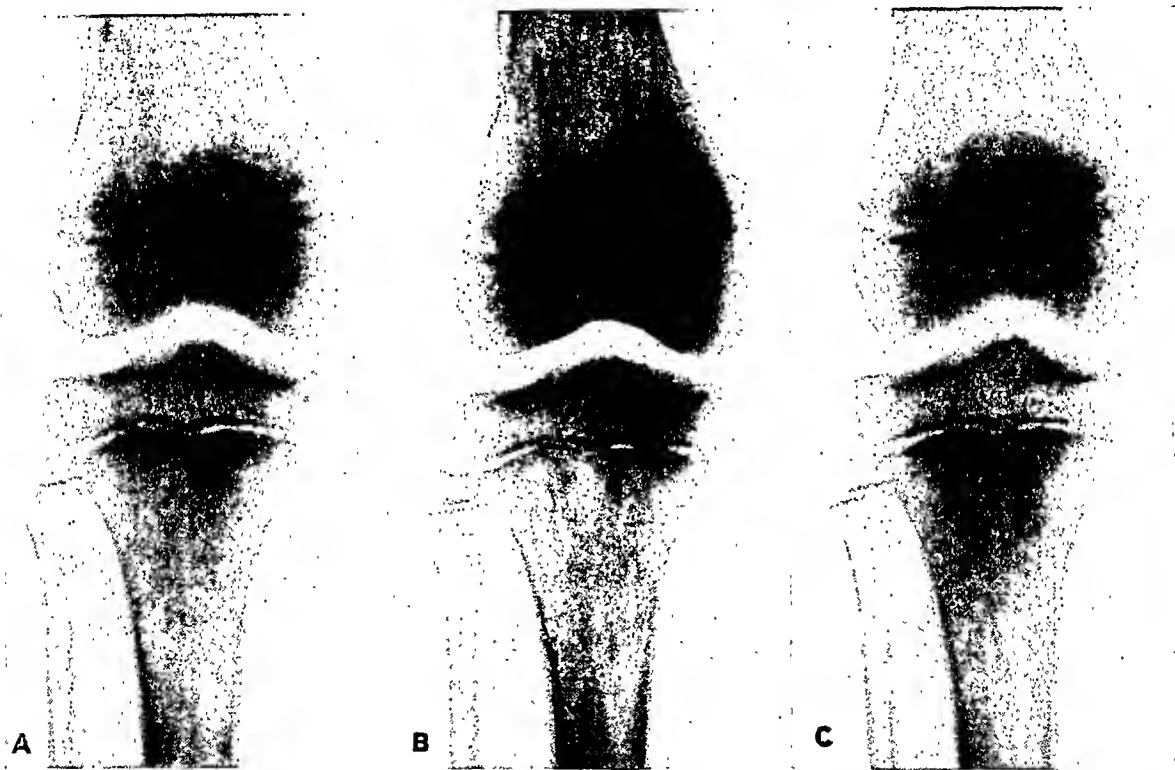


Fig. 1. Case I. A. Roentgenogram taken March 14, 1944, showing no definite evidence of any change in the tibia. B. Roentgenogram taken March 24. An area of rarefaction has appeared in the upper portion of the metaphysis adjacent to the epiphyseal line, accompanied by a very faint elevation of the periosteum. C. Roentgenogram taken April 27. The area of osteomyelitic involvement in the upper portion of the metaphysis shows recalcification, the involved area appearing slightly denser than the surrounding bone. There has been no evidence of sequestration, extension of the process, or involucrum.

acute and chronic, with varying results. In general, the period of active infection has been shortened and the clinical results have been gratifying. The following case summaries and illustrations demonstrate what we believe to be the typical changes

in the general physical condition of the patient. In some of the cases it was possible to do elective surgery concurrent with the administration of penicillin, with no extension of the infection. In the acute cases which proved susceptible to penicillin, clinical improvement preceded the roentgenographic signs of healing, and the patient became clinically well. We do not

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Fig. 2. Case II. A. Roentgenograms taken Oct. 20, 1943. Chronic osteomyelitis of the lower end of the right radius. This area and those in the upper metaphysis of the left tibia and the lower metaphysis of the right femur (see Fig. 3) represent osteomyelitis of approximately the same age. There is a moderate amount of sclerosis with no evidence of large sequestra and with only a moderate involucrum. B. Roentgenograms taken April 26, 1944. Corresponding views of the area reproduced in A show no evidence of further extension of the osteomyelitic process, no further sequestration, no further involucrum, and there is recalcification of the previously involved areas, the recalcified bone approaching the normal in texture and appearing only slightly more dense.

feel that it is by any means established that in bone infections treatment with penicillin is a substitute for adequate drainage, when necessary, or for other surgical procedures which have proved of benefit in the past. In a few of these cases the clinical response was so rapid that surgical drainage was not instituted. Not all of the patients showed a prompt response to the penicillin, but in those which did, certain bone changes occurred.

#### CASE REPORTS

CASE I: E. M. B., an 11-year-old boy, was admitted to the clinic March 14, 1944, with pain in the right knee of three days' duration. Examination showed tenderness over the upper fourth of the right tibia with a slight soft-tissue swelling below the medial condyle anteriorly. There was a slight increase in joint fluid, and motion in the knee was guarded and painful. The temperature on admission was  $101^{\circ}$ , the white blood count 14,000; urinalysis showed ketone bodies. The roentgenograms were negative (Fig. 1, A).

The administration of penicillin was instituted on admission: 1,000,000 units were given intramuscularly, 10,000 units every three hours. The patient's temperature rose to  $103^{\circ}$  on the first day, and until the fourteenth day it continued to show an afternoon elevation to as high as  $102^{\circ}$ . It then returned to  $98.6^{\circ}$  and remained normal thereafter.

Roentgenograms made March 24, after 800,000 units of penicillin had been given, showed a localized area of rarefaction in the tibial shaft adjacent to the epiphyseal line (Fig. 1, B). The patient was discharged from the hospital on the fifteenth day, with a normal temperature and a leukocytosis of 12,800. The upper end of the tibia was painless.

The patient returned to the clinic for examination on April 27, a month after the penicillin had been given, and roentgenograms (Fig. 1, C) of that date showed recalcification of the area of destruction seen in the earlier films. The area in which bone repair had taken place was slightly denser than the surrounding bone, and there was a slight periosteal reaction around the upper portion of the shaft of the tibia. There was no evidence of sequestration, spread of infection, or involucrum.

CASE II: P. G., a 15-year-old boy, was first seen at the clinic July 30, 1943. His entering com-



Fig. 3. Case II. A. Roentgenograms taken Oct. 20, 1943, showing osteomyelitis of the upper metaphysis of the left tibia and the lower metaphysis of the right femur. B. Roentgenograms of the corresponding areas taken April 26, 1944, after treatment. See Figure 2.



Fig. 4A. Case III. Roentgenograms taken March 6, 1944. Two views of the right femur show osteomyelitis involving the upper portion of the shaft and apparently invading the trochanteric area. There are bone destruction, early involucrum, and no definite sequestration.

plaint was multiple osteomyelitis of four weeks' duration. The first focus of infection was on the medial aspect of the right foot, followed within a week by foci in the left lower femoral metaphysis, right lower femoral metaphysis, and the right lower radial metaphysis. A soft-tissue abscess of the forearm had been aspirated, a sequestrectomy had been done on the upper portion of the left tibia, and a soft-tissue abscess over the right radius had been incised before the patient was seen here. On examination he appeared seriously ill, with draining sinuses from the right radius and left lower femur, generalized swelling and tenderness of the lower ends of both femora and of the right radius. His temperature on admission was  $100^{\circ}$ , rising the following

day to  $104^{\circ}$ . His white blood count on admission was 12,800 (polymorphonuclear neutrophils 72 per cent), red blood count 2,850,000. The blood culture was negative.

The patient was admitted to the hospital, and six days later, Aug. 5, incision and drainage of the right lower femur were done. Culture on this date showed *Staphylococcus aureus hemolyticus*. The patient was given numerous blood transfusions. Prior to admission he had received a large amount of sulfathiazole, and this was continued during his stay in the hospital. Roentgenograms taken on July 30 showed multiple foci of osteomyelitis involving the lower metaphysis of the right femur, the lower metaphysis of the left femur, the upper metaphysis of





Fig. 4B. Case III. Roentgenograms taken April 10, 1944. There is no evidence of a destructive process, no sequestration, no further involucrum formation. Early recalcification of the involved areas has occurred, the recalcification appearing slightly more dense than normal bone.

the left tibia, the lower metaphysis of the right radius, and the proximal phalanx of the third toe on the left. Under conservative treatment there was a gradual improvement, and drainage decreased, but continued. Improvement was slow, and the roentgenograms showed only the changes commonly seen in osteomyelitis which has been adequately drained, namely, little evidence of sequestration, some periosteal new bone formation, and a moderate amount of sclerosis (Figs. 2, A and 3, A). The sinuses, however, continued to drain actively, with a positive culture of *Staphylococcus aureus hemolyticus*.

The patient was given 500,000 units of penicillin beginning on Oct. 20. The response was dramatic. The drainage decreased rapidly and the sinuses diminished in size; the pain disappeared, and in three weeks the patient was able to be up and about. One small sinus over the right wrist continued to drain intermittently.

The patient returned to the clinic on April 26,

1944, and on that date all the sinuses had closed, the temperature had been normal for three months, and he had returned to school and resumed all normal activities. Roentgenograms showed a rather marked sclerosis of bone in the involved areas; there had been no extension of the destructive process and no sequestration (Figs. 2, B and 3, B).

*Comment:* In this case the multiple bone lesions were foci of hematogenous osteomyelitis of approximately the same age, showing no great tendency toward sequestration. Adequate surgical drainage had been done, and the patient showed a dramatic and remarkable response to the penicillin. It was of interest to us that the progress of the infection was arrested. There was no extension of the osteomyelitic process, no large amount of



Fig. 5A. Case IV. Roentgenograms taken Jan. 12, 1944, showing necrosis and sequestration of the body of the astragalus with an old unhealed fracture of the neck of the astragalus, osteoporosis, and definite bone destruction in the adjacent scaphoid and cuboid.

involucrum formed, and there was definite evidence of early recalcification of the infected areas.

CASE III: Mrs. G. P., a 56-year-old woman, came to the clinic Feb. 24, 1944, with a painful right thigh. Three weeks previously a carbuncle on the right shoulder had been excised and the area skin-grafted. The patient was first seen in consultation at another hospital. On examination she appeared acutely ill; her temperature was  $102^{\circ}$ , and white blood count 9,800. Blood culture was positive for *Staphylococcus aureus*. Roentgenographic examination of the right femur showed an extensive osteomyelitis with bone destruction involving the proximal one-third of the femur and elevation of the periosteum on the inner surface (Fig. 4A).

The patient was given 5,000 units of penicillin every two hours until a total of 1,000,000 units had been given. The third day after the penicillin therapy was instituted, the temperature dropped to  $98.6^{\circ}$  and remained normal thereafter. Pain and tenderness disappeared, and the patient was dis-

charged on March 17. She returned to the clinic for check-up roentgenograms on April 10, 1944 (Fig. 4B). Films at that time showed extensive bone replacement and callus deposition along the line of periosteal reaction. The patient remained clinically cured.

*Comment:* This patient did not have surgical drainage. She had an acute hematogenous osteomyelitis with a positive blood culture. Clinical cure was achieved, and the roentgenograms showed that the infection had been checked, that no sequestration or extension occurred; there was no involucrum, and the involved areas showed a tendency toward rapid recalcification.

CASE IV: C. L., a 43-year-old man, was admitted to the clinic Oct. 3, 1943, having fallen from a second-story window. On examination he showed a compound fracture-dislocation of the left astrag-



this was done on Feb. 21, 1944. The patient was given penicillin, 10,000 units every two hours, for two days preoperatively, and penicillin was continued postoperatively until the seventh day, 1,000,000 units being given over this period. Following the operation, the temperature rose daily to  $101^{\circ}$ . On the twelfth day, however, it returned to  $98.6^{\circ}$  and remained normal thereafter.

Roentgenograms taken on Jan. 12, 1944 (Fig. 5A), after the first course of penicillin, showed sequestration of the body of the astragalus and a



Fig. 5B. Case IV. Roentgenograms taken April 24, 1944. Surgical removal of the body of the astragalus has been done, and an early calcaneotibial fusion obtained. There is an increase in the osteoporosis of the adjacent bones, but there is no evidence of increased destruction and no sequestration.

alus. At the time he was first seen, the fracture was eight hours old. Immediate débridement and reduction were done, sulfanilamide being placed in the wound. Sulfathiazole was also given by mouth. On the sixth day, however, signs of local infection developed about the fracture. The sutures were removed and a large quantity of purulent material was evacuated, culture of which showed gram-positive cocci in pairs, bunches, and short chains, as well as gram-positive bacilli. The temperature at the time of onset was  $101^{\circ}$ . Following adequate drainage of the infection, the temperature returned to  $98.6^{\circ}$  and remained normal throughout the subsequent period of treatment, although sinuses about the wound continued to drain. The reduction of the astragalus was maintained, but roentgenograms taken on Dec. 13 showed definite necrosis of the body of the bone. The wounds continued to drain and the patient remained afebrile. Cultures from the wound continued to show a mixed infection of *Staphylococcus* and gram-positive bacilli.

The patient was given a course of 500,000 units of penicillin over a period from Dec. 21 to Dec. 27, but there was no change in the character of the drainage other than that the *Staphylococcus aureus hemolyticus* at the end of the penicillin course was cultured as non-hemolytic *Staphylococcus aureus*. It was then decided to do an astragalectomy and a calcaneotibial fusion, in spite of the infection, and

considerable amount of destruction involving its neck. There was a definite loss of ankle joint space, with some demineralization of the distal end of the tibia. In addition to involvement of the neck of the astragalus, there was involvement of all of the tarsal bones, which showed demineralization and bone destruction. Roentgenograms taken postoperatively showed no evidence of extension of the infection. The sequestrum had been completely removed surgically and a calcaneotibial fusion had been done. There was no further sequestration, nor was there any further involvement of the adjacent tarsal bones (Fig. 5B). The clinical course was excellent.

*Comment:* This case illustrates the possible use of penicillin in elective surgery done in infected fields with no spread of the infection. In this particular instance a rather extensive operation was done, of a type which, in the past under similar circumstances, would be frequently followed by such extensive spread as to amount to a surgical disaster.

CASE V: C. J. E., an 11-year-old boy, was admitted to the Baptist Memorial Hospital with a history of infection of the lower portion of the right

tibia of seven weeks' duration. The area had been incised and drained twice before admission, and pus had been evacuated. The right leg showed generalized swelling of the lower two-thirds, with a definite area of fluctuation proximal to the medial malleolus of the tibia. There were two small in-

Penicillin therapy was instituted immediately, 5,000 units being given every two hours for sixteen days, representing a total of 920,000 units. On April 21, two days after admission, the soft-tissue abscess was incised and drained, vaseline gauze was packed in the wound, and a cast was applied. On

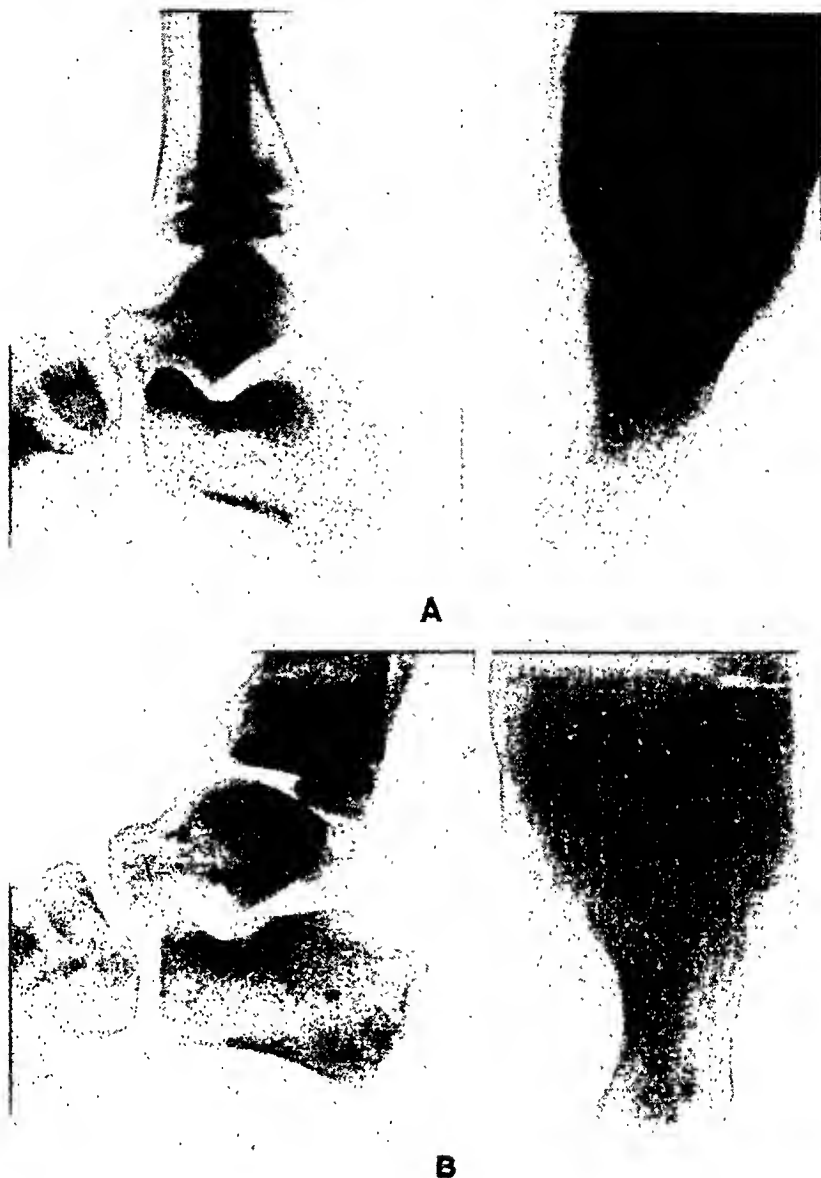


Fig. 6. Case V. A. Roentgenograms taken April 20, 1944, showing extensive osteomyelitis involving the lower metaphysis of the right tibia, with extensive destruction, apparent early sequestration of the lateral cortex, and early involucrum formation. B. Roentgenograms taken May 6, 1944. There is no further sequestration, no further extension of the osteomyelitic process, and no increase in the involucrum. Early recalcification of the involved areas has occurred.

cisions with purulent drainage from each. The temperature on admission was  $101^{\circ}$ , the white blood count was 11,600, the blood culture was negative, and the wound culture showed *Staphylococcus aureus*.

the same day the patient was given 500 c.c. of whole blood. The temperature continued to show daily elevations until the thirteenth day, when it returned to  $98.6^{\circ}$ , remaining normal thereafter.

Roentgenograms taken at the time of admission

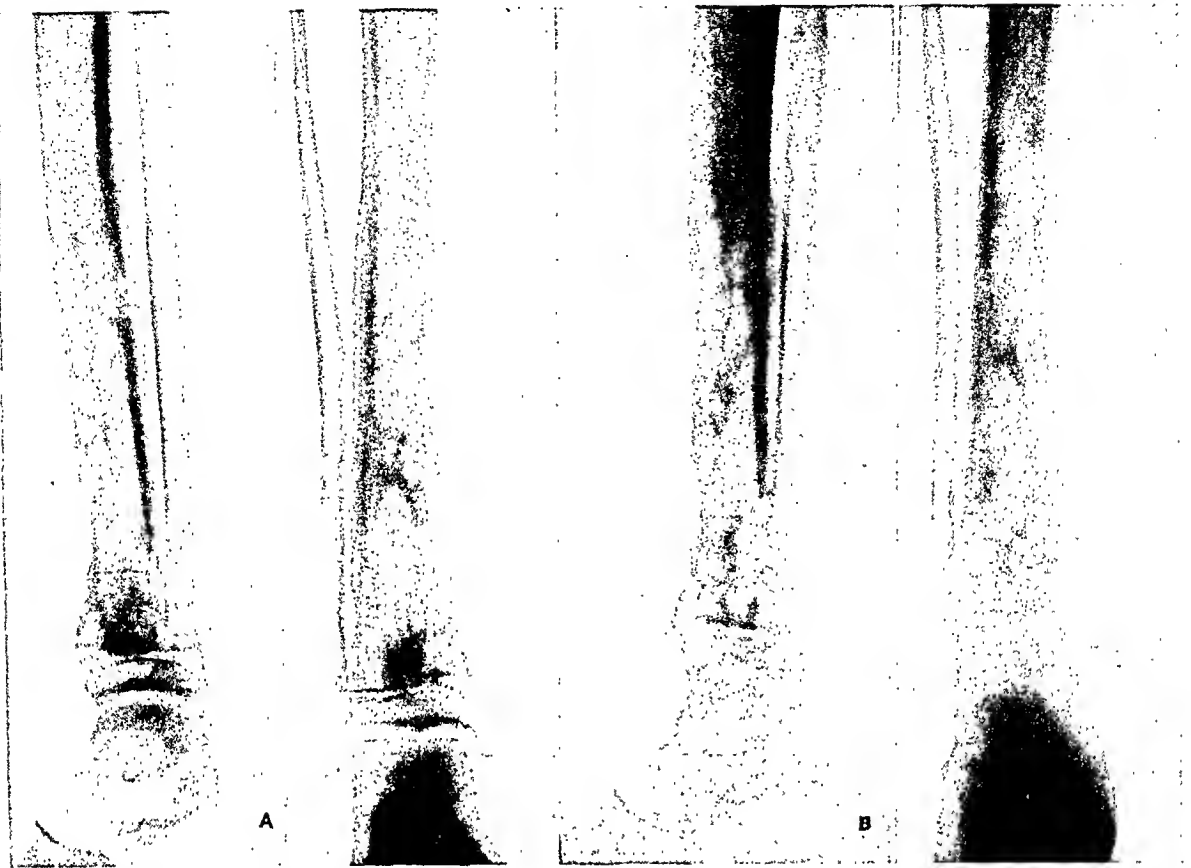


Fig. 7. Case VI. A. Roentgenograms taken Sept. 1, 1943, showing an early osteomyelitis involving the posterior portion of the os calcis, with small areas of decreased density. B. Roentgenograms taken April 13, 1944, showing recalcification in the posterior portion of the os calcis previously involved by osteomyelitis. This recalcification is slightly denser than the normal surrounding bone. There is no evidence of sequestration or extension of the process.

(April 20) showed an area of destruction involving the lower metaphysis of the tibia with apparent early sequestration of the lateral cortex (Fig. 6, A). On May 6, seventeen days after penicillin treatment was instituted, the cast was removed. The incised area was found to have filled in with granulation tissue and no definite sinus was present. Roentgenograms of this date showed no further extension of the osteomyelitis, and the area of cortical bone which had appeared to be sequestering showed an apparent arrest of the sequestering process. There was little evidence of involucrum, and the areas of bone destruction showed an early recalcification (Fig. 6, B).

CASE VI: F. J. R., a 5-year-old boy, was admitted to the clinic on Aug. 25, 1943, with a painful right heel with fever. One month prior to admission he had had furuncles on both thighs, eight of these having been opened at one time. He was given a course of sulfa drugs following the opening of the initial lesions, but he continued to show successive furunculosis. Five days before admission a large furuncle appeared on the left thigh, and simultaneously the right heel became painful, causing

a limp. Three days before admission fever developed. Two days before admission an attempt was made to drain the heel, but no pus was found. On examination the heel was tender to pressure but there was no evidence of localized infection in this region. The white blood count was 8,200, with 56 per cent polymorphonuclear cells. The temperature was 103° on admission, and showed daily afternoon rises to 103° thereafter.

The patient remained in the hospital for four days, during which time he was given sulfathiazole. The leg was placed in a plaster cast without drainage, and he was then transferred to another hospital for penicillin therapy. Roentgenograms taken on Sept. 1, 1943, ten days after the onset of symptoms, showed a definite area of osteomyelitis of the posterior portion of the right os calcis (Fig. 7, A). The patient was given a course of 1,000,000 units of penicillin intramuscularly, 10,000 units every three hours. Three days after the institution of this treatment the temperature returned to 98.6° and remained normal thereafter. The leg was kept in a plaster boot cast for two months and no further symptoms developed.

The patient returned to this clinic April 13, 1944, for additional films. On this date he was clinically well, and the roentgenograms showed no evidence of sequestration or extension of the infectious process; there was recalcification throughout the previously involved area (Fig. 7, B).

*Comment:* This case represents an acute hematogenous osteomyelitis of the os calcis apparently cured without surgical drainage, the roentgenograms showing no extension of the infection or sequestration in an area of cancellous bone prone to show sequestration and extension.

#### CONCLUSIONS

The case summaries presented represent several types of bone infection in which we feel that definite improvement followed the use of penicillin. It is our opinion that, in general, the treatment of bone infections with penicillin has been satisfactory. The response varies in individual cases. In most instances the period of active infection was considerably decreased. In those cases which showed a favorable response to penicillin, clinical improvement preceded any roentgenographic evi-

dence of healing. The roentgenographic evidence which we have seen in our cases is as follows:

(1) Apparent arrest of the spread of the infection with little or no sequestration of bone and little or no involucrum.

(2) Positive evidence of healing, in the form of a reactive recalcification of the affected areas, the recalcification appearing throughout the cortex of the bone and approaching the normal architecture of the bone much more closely than does the ordinary involucrum in osteomyelitis. The area of recalcification was of slightly greater density than normal bone.

(3) Since the progress of the infection in these cases was apparently arrested and the reparative process began before extensive spread, sequestration, and involucrum had appeared, the resultant end sclerosis was less than has been commonly seen in extensive osteomyelitis which has run the normal evolutionary course.

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# Lethal Dose Studies with X-Rays<sup>1</sup>

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## I. INTRODUCTION

BIOLOGICAL evaluation is as indispensable in study of the therapeutic potentiality of radiations as in that of drugs, hormones, or vitamins. This is particularly true of radiations of short wave length, such as x-rays, which are known to produce permanent and irreversible changes.

It is well known that there are two fundamentals upon which the evaluation of any therapeutic agent is based (Sollmann, 4): its local action and its toxicity when applied to the entire animal. Studies of the latter type are also called lethal dose studies. In the case of x-rays, relatively satisfactory data are available concerning the local action on various tissues and in different animal species (Ellinger, 2). No such facts have been established, however, for the toxicity of x-rays in general body irradiation. The literature, it is true, contains scattered references to the lethal effect of whole body irradiation for a variety of animals, but most of these data have been obtained under conditions which preclude any accurate evaluation of the results.

A systematic study of lethal doses of x-rays seems, therefore, to be desirable from several points of view. In the first place, investigation along this line promises a better understanding of some of the already known effects of x-rays. This may well lead to improvement in the application of radiation therapy and may even open new fields for this form of treatment. In the second place, such studies may furnish data upon which to base a more effective treatment of generalized malignant growth, with less accompanying toxemia. Finally, a more detailed knowledge of lethal doses of x-rays will be of

value in the use of artificial radioactive substances as therapeutic agents. The main purpose of lethal dose studies with x-rays is, therefore, (1) to establish lethal doses for various animal species under well defined conditions of irradiation, which will make the data thus obtained generally applicable; (2) if at all possible, to relate lethal doses to body weight or body volume or, if there is no such relationship, to consider the problem of species specificity; (3) to establish the percentage of the lethal dose necessary to produce destructive effects on organs and tumors for various animal species; (4) to establish correlation factors applicable to man, on the basis of lethal doses for animals.

The terms "lethal dose" and "sublethal dose" have been used in experimental studies on the effects of radiation with a great variety of meanings. As used throughout our investigations, "*sublethal dose*" designates any amount of radiation producing no mortality within a given period of time, while "*lethal dose*" designates any amount of radiation producing a certain percentage of fatalities within a given period of time. It is obvious that without the inclusion of a time factor these terms are meaningless. On the basis of previous experience (Ellinger, 1), therefore, we have chosen twenty-eight days as the total observation period and fourteen days  $\approx$  20 per cent as the time factor for the definition of lethal dose.

Since the definition of "lethal dose" as given above makes it evident that there is not a single lethal dose but rather various lethal doses, further subdivision of this term becomes necessary. These subdivisions will be made in conformity with the nomenclature used in recording drug action (Munch and Garlough, 3). Thus in a general study of lethal doses we must differentiate:

<sup>1</sup> Aided by a grant from Wm. R. Warner & Co. Accepted for publication in June 1944.



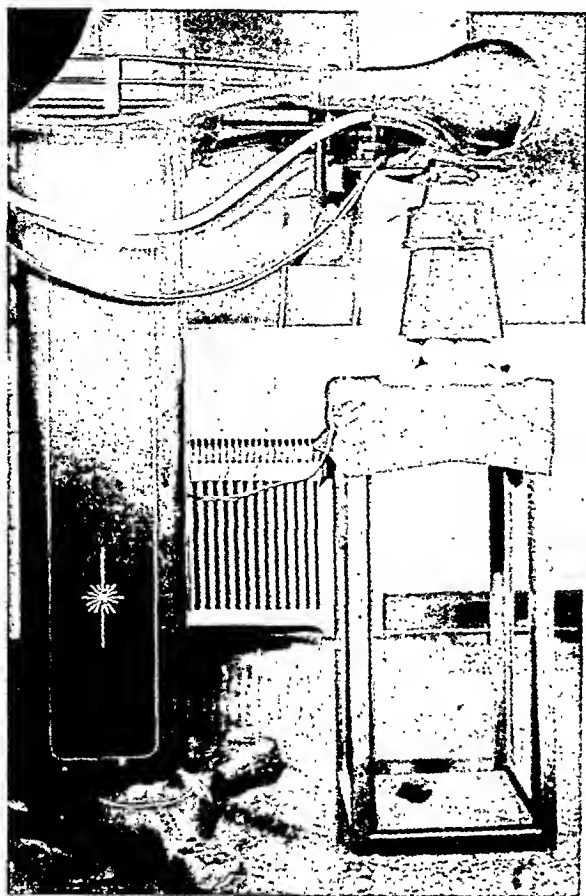


Fig. 1. Method of exposure of animals to radiation.

#### A. Sublethal Doses

- (1) Ineffective Doses: Doses producing no change in the normal appearance or organ function.
- (2) Minimum Effective Doses (MED): The amount of radiation producing changes in the appearance or proper organ function of the irradiated animals.

#### B. Lethal Doses

- (1) Minimum Lethal Dose (MLD): The amount of radiation producing a few (at least 10 per cent) fatalities.
- (2) Lethal Doses of Various Percentage Mortality (LD)<sup>2</sup>: The use of the 50 per cent lethal dose, LD<sub>50</sub>, has been proposed by Trevan (5) as especially suitable for comparative studies.

- (3) The Absolute Lethal Dose (ALD): The amount of radiation invariably producing death of all animals within a given period of time.

#### II. DETERMINATION OF THE LETHAL DOSE FOR MICE

Previous investigations (8, 9) have established the lethal dose of x-rays for a small cold-blooded animal, the common goldfish (*Carassius auratus*). The present work represents an extension of these studies to a small warm-blooded animal, the white laboratory mouse.

*Technic:* The radiation factors employed were as follows: 200 kv.p.; 10 ma.; 0.13 mm. Sn, 0.25 mm. Cu, and 1.0 mm. Al filtration, corresponding to a half-value layer of 1.25 mm. Cu. The intensity of radiation was 15.6 r per minute. The distance from the target to the animal container was 50 cm. in all experiments. The total field size was 20 × 20 cm. The doses ranged from 200 to 1,000 r (measured in air) and were given in every instance in one continuous exposure.

A total of 200 male white mice were used in these experiments, 44 of which served as unirradiated controls. The average weight of the animals at the time of exposure was 20 gm. ± 15 per cent.

For each exposure 6 mice were used, each being placed in a small paper bag which was then inserted in a small linen bag. It was thus possible to expose the animals under most natural conditions, without the use of any anesthetic which might have influenced the susceptibility to irradiation. The bags containing the mice were placed on a wooden frame 118 cm. high, the top of which measured 44 × 44 cm. The opening of the frame was covered with a sheet of linen. On this sheet, bags of rice 10 cm. high were placed as a constant scattering medium, as shown in Figure 1. Each exposed lot of mice was kept in one cage. The animals were fed with Purina dog chow and vegetables and kept under daily observation for at least twenty-eight days.

*General Appearance of Irradiated Mice:* For two to five days after exposure (de-

<sup>2</sup> The percentage designated by an index figure

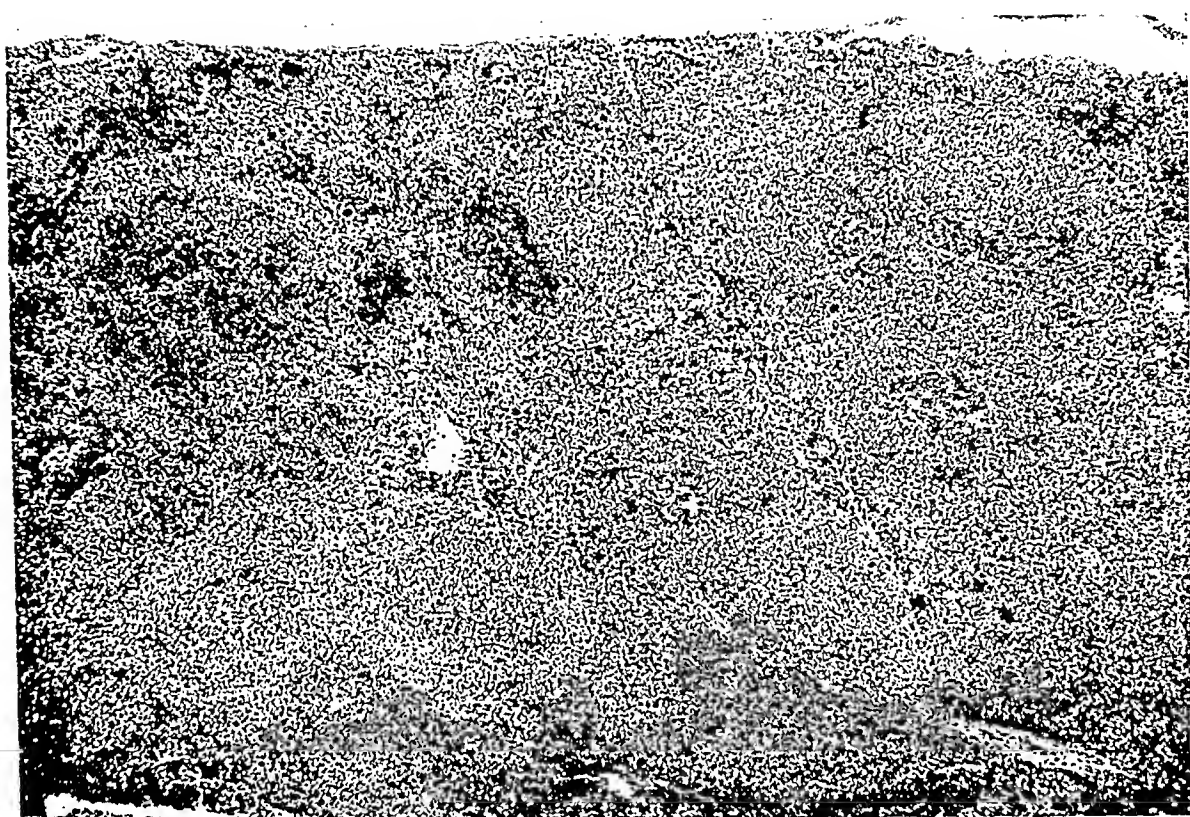


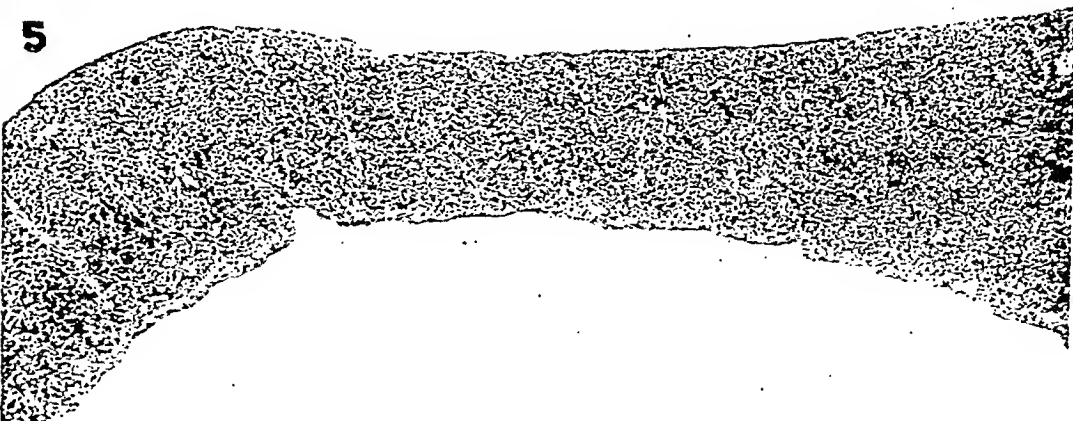
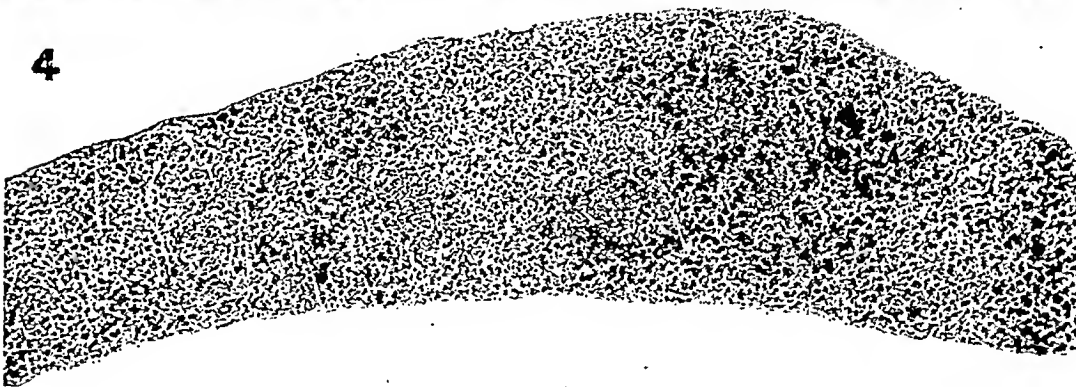
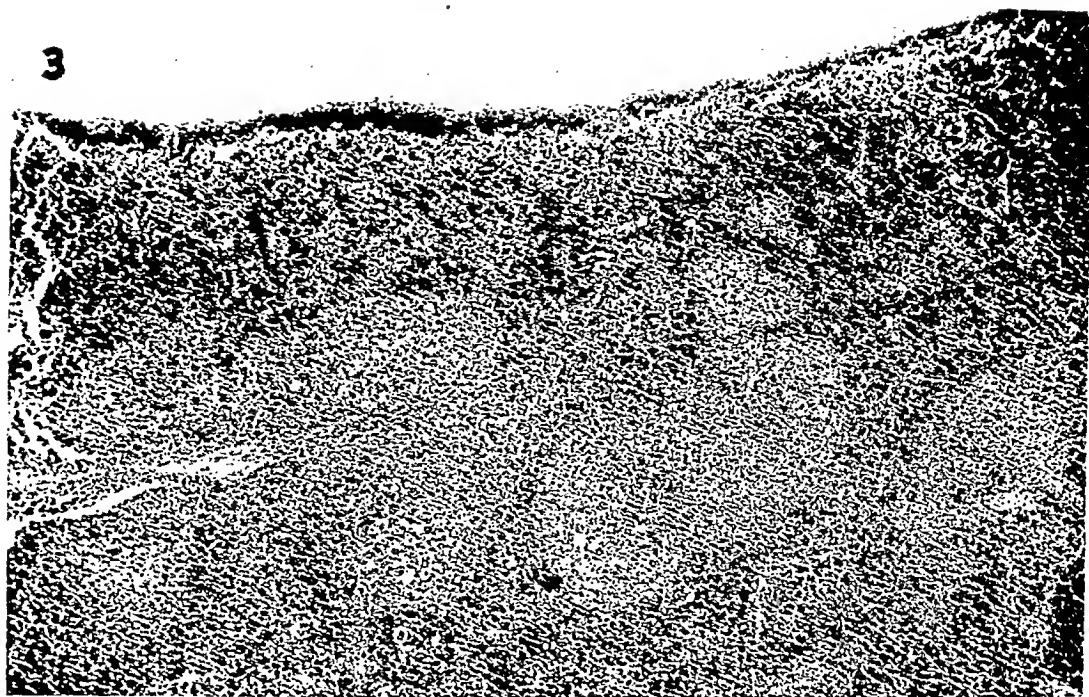
Fig. 2. Spleen of a normal mouse, showing the distinctly outlined malpighian bodies.  $\times 60$ .

pending on the dose) there was a latent period in which the appearance of the treated mice differed in no way from that of the unirradiated controls. After five days, mice exposed to doses between 200 and 600 r in air usually exhibited shaggy fur, loss of appetite, and diarrhea. The first fatalities coincided with the appearance of these symptoms. Surviving animals usually regained normal appearance between the fourteenth and twentieth day after exposure. In the animals exposed to doses of 800 or 1,000 r in air, the first fatalities occurred, without prodromal signs or symptoms, on the second day after exposure. Some animals, however, appeared severely ill on the third or fourth day after irradiation, exhibiting somnolence, dyspnea, and diarrhea. These symptoms were followed by death in a large percentage of instances.

*Postmortem Examinations:* Postmortem examinations revealed severe injury to the hematopoietic tissues, the changes being most conspicuous in the spleen and bone

marrow. With increasing doses, atrophy and shrinkage of the lymphatic tissues increased. With the highest doses, the spleen was reduced to about one-third of the normal average size.

Histologic examinations revealed progressive depletion of the lymphatic elements of the bone marrow and spleen in direct proportion to the doses employed (Figs. 2-9). The malpighian bodies of the spleen, in particular, permitted some quantitative evaluation of the radiation effect. Following the application of 200 r the malpighian bodies were distinctly outlined but showed a reduction in white blood elements on the seventh to the twelfth day after exposure. On the ninth day after exposure to 600 r in air there were only a few cells remaining and on the fourth day after exposure to 1,000 r in air not even traces of malpighian bodies could be found (Fig. 5). It seems noteworthy that the sternal bone marrow was practically devoid of white elements on the ninth day after the application of 600 r

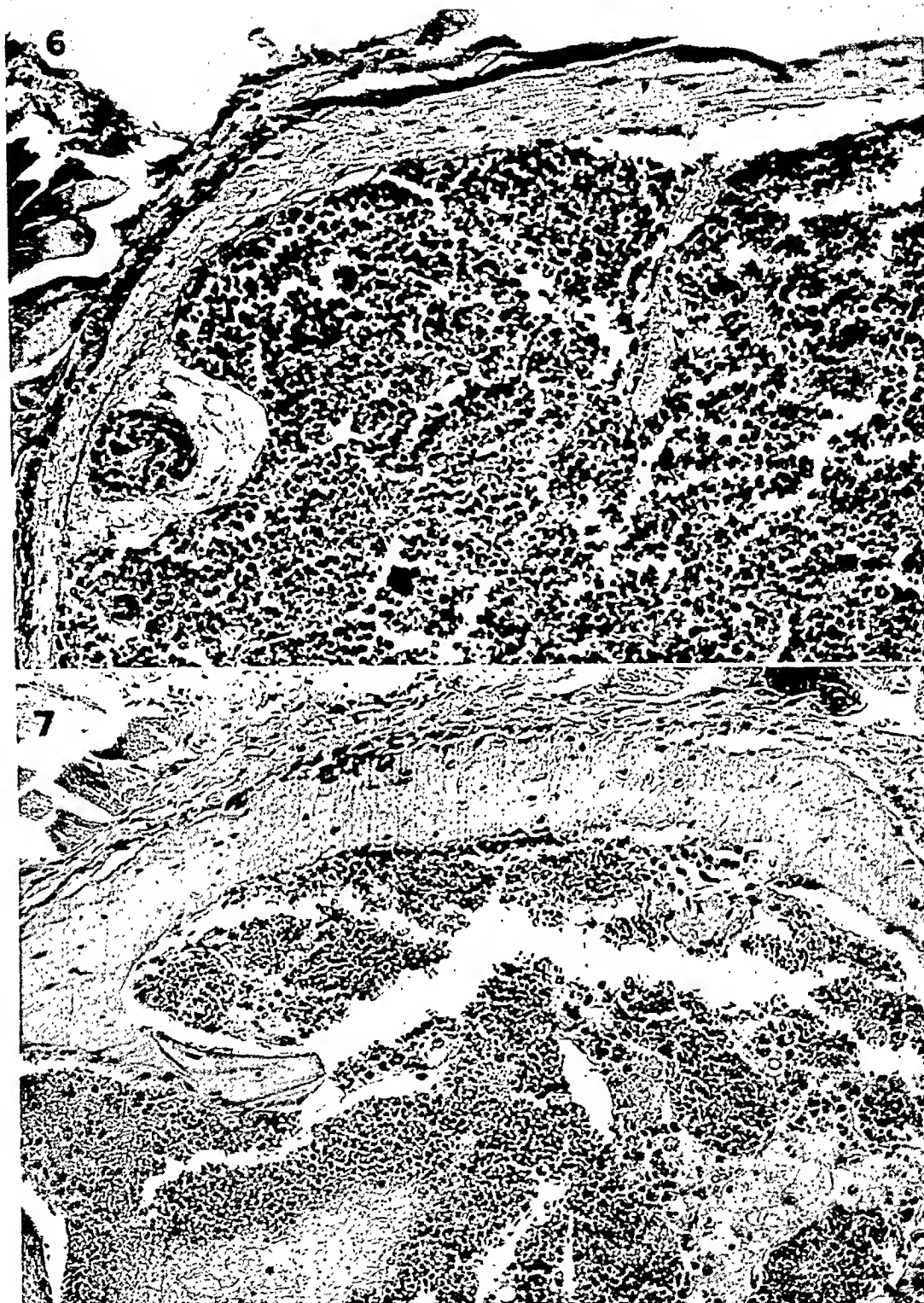


Figs. 3-5. Effects of radiation on the spleen.

Fig. 3. Spleen of a mouse which died on the seventh day after exposure to 200 r in air. The malpighian bodies are distinctly outlined but the white blood elements are reduced.  $\times 60$ .

Fig. 4. Spleen of a mouse which died on the ninth day after exposure to 600 r in air. Only a few remnants of malpighian bodies are visible. Notice the considerable shrinkage of the spleen in comparison with Figure 2.  $\times 60$ .

Fig. 5. Spleen of a mouse which died on the fourth day after exposure to 1,000 r in air. Not even traces of malpighian bodies are left. Further progress in shrinkage.  $\times 60$ .

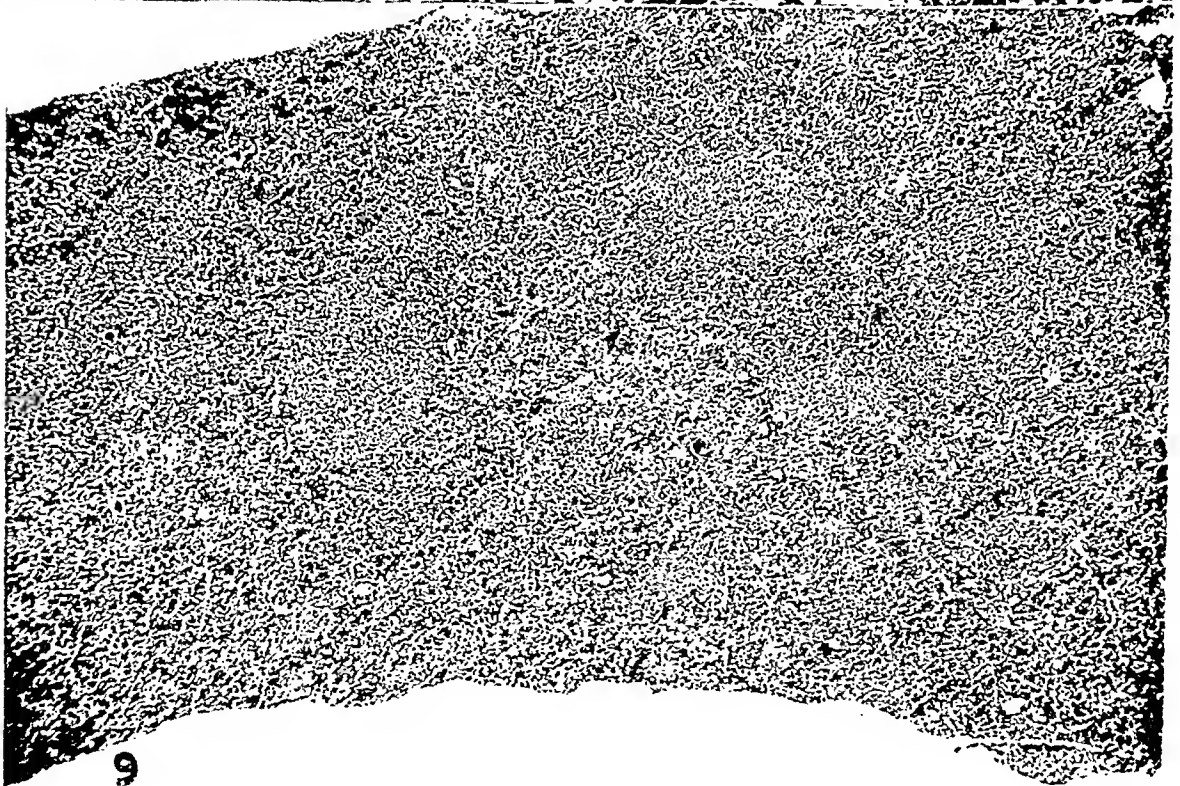
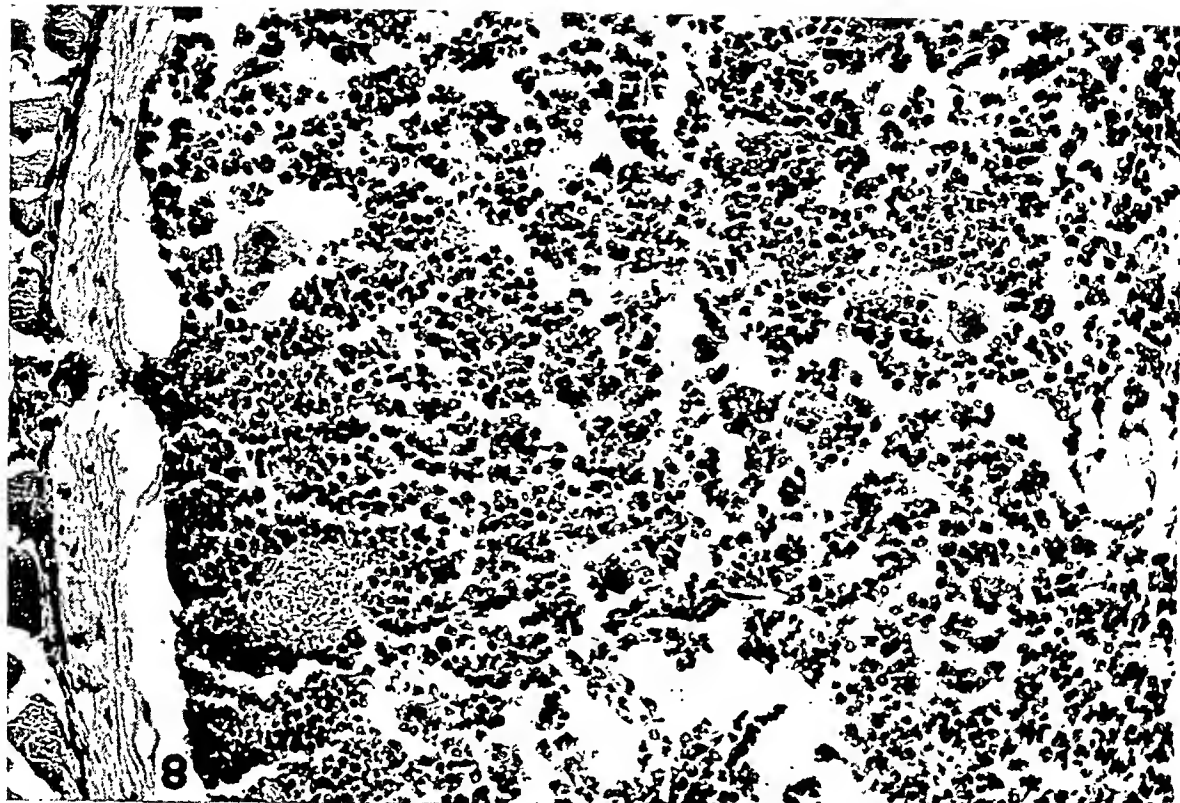


Figs. 6 and 7. Effect of radiation on the bone marrow.

Fig. 6. Normal sternal bone marrow of a mouse.  $\times 300$ .

Fig. 7. Sternal bone marrow of a mouse which died on the ninth day after exposure to 600 r in air. The bone marrow is almost devoid of white elements.  $\times 300$ .





Figs. 8 and 9. Bone marrow and spleen.

Fig. 8. Sternal bone marrow of a mouse killed twenty-eight days after exposure to 600 r in air. Almost normal appearance in comparison with Figure 6.  $\times 300$ .

Fig. 9. Spleen of a mouse killed twenty-eight days after exposure to 600 r in air. While the bone marrow of the same animal (Fig. 8) appears almost normal, the malpighian bodies of the spleen, when compared with those of a normal spleen (Fig. 2), appear less distinctly outlined, thus indicating a slower recuperative power of the spleen.  $\times 60$ .

in air. The fact that, in spite of this, many animals recovered, while none recovered when the malpighian bodies were destroyed, confirms the general opinion that the bone marrow is characterized by greater sensitivity and power of recuperation than the spleen. In support of this statement, it may be mentioned that, in a mouse killed on the twenty-eighth day after exposure to 600 r, the bone marrow appeared entirely normal, while the malpighian bodies of the spleen were less

effect of x-rays, 24 animals were exposed for each dose, except the smallest—200 r in air—for which 41 mice were employed. The number of dead animals was recorded daily up to the twenty-eighth day. No mortality was observed among the unirradiated controls within this period.

A graphic presentation of the results obtained is given in Figure 10. The abscissa denotes the days after exposure, while the ordinate denotes percentage mortality. The curve for each dose is the *lethal dose*

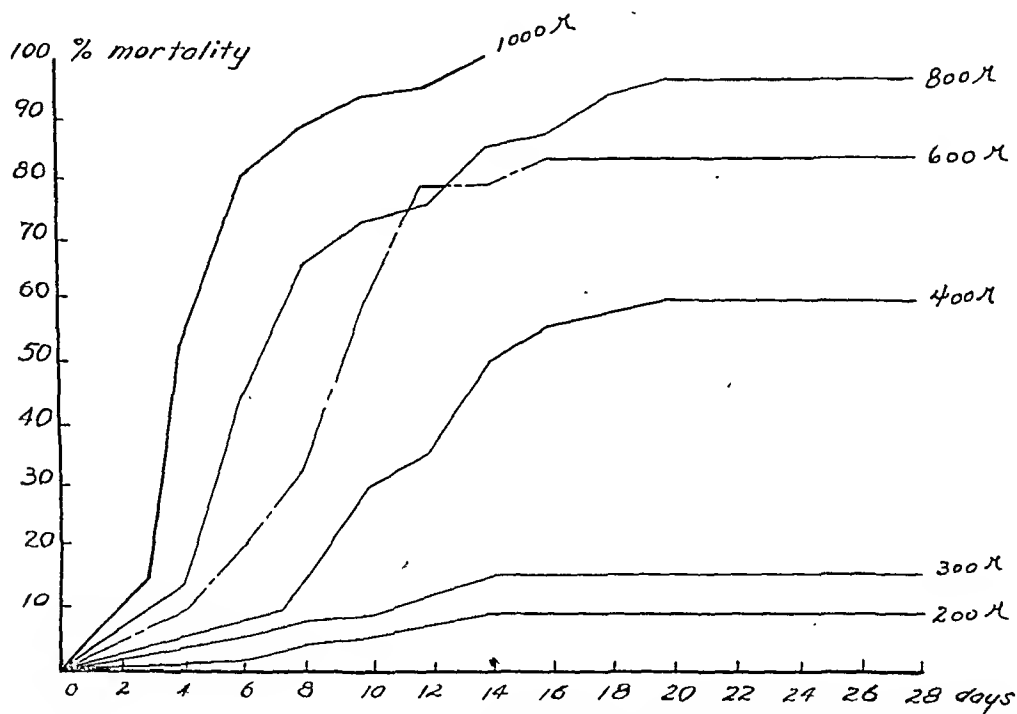


Fig. 10. Lethal dose curves for mice. The mortality increased progressively as the doses were raised from 200 to 1,000 r in air.

distinctly outlined than in the unirradiated control (Figs. 8 and 9). Mice killed 181 days after exposure to 200 r in air showed an entirely normal appearance of spleen and bone marrow.

Besides the changes in the spleen, hemorrhages in the small intestine, and less frequently along the greater curvature of the stomach, were the most conspicuous gross anatomical findings. Details of the postmortem findings in other organs will be considered in a later publication.

*Relationship between X-Ray Doses and Mortality:* For the study of the lethal

curve. As can be seen, the mortality increased progressively as the doses were raised from 200 to 1,000 r in air. While with a dose of 200 r a maximum mortality rate of 10 per cent within twenty-eight days was obtained, the mortality reached 100 per cent within fourteen days after the application of 1,000 r.

In accordance with the definitions given above (p. 126), 200 r in air represents, under our conditions of exposure, the *minimum lethal dose (MLD)*, while 1,000 r in air represents the *absolute lethal dose (ALD)*.

In order to compare the lethal effect of x-rays in various animal species and under different conditions of irradiation, it is necessary to plot a *mortality curve*. This curve is obtained by plotting the doses of x-rays in r on the abscissa and using the percentage mortality as the ordinate. Figure 11 is the mortality curve for mice on the fourteenth day after exposure. As in the study of the lethal effect of x-rays on single cells (10) and in studies using goldfish as the test object (8, 9), the rela-

servations presented here amply confirm this statement. At the same time, our findings permit the correlation of this biologically established lethal dose with its physical equivalent expressed in r. It may be recalled that in our series complete destruction of the malpighian bodies of the spleen was brought about with a dose of 1,000 r in air, which killed all animals within fourteen days.

As far as we know, the earliest attempt to assess the lethal effect produced by total

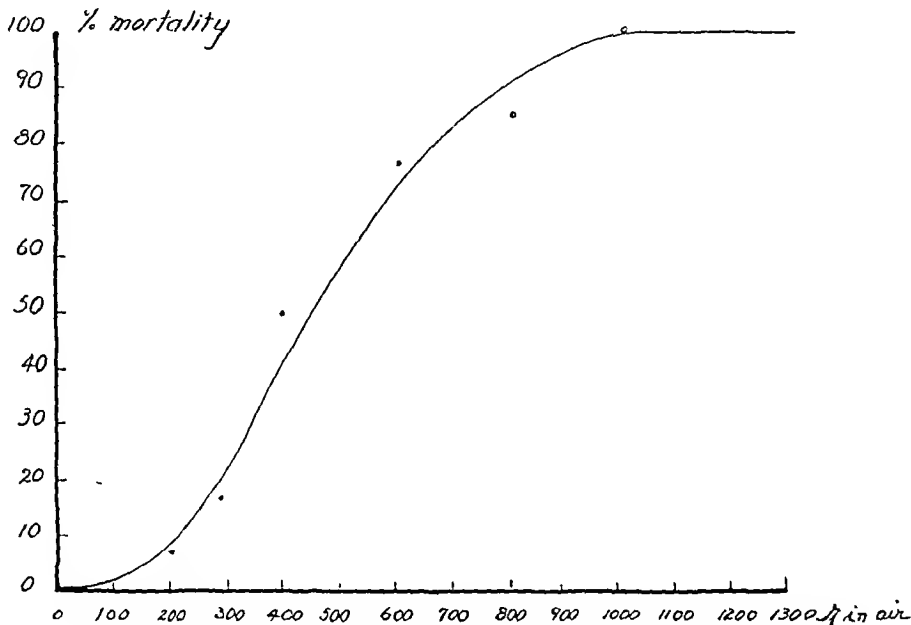


Fig. 11. Mortality curve for mice, fourteenth day after exposure to x-rays.

tionship between the dose and the effect has been found to follow an S-shaped curve.

### Discussion

The literature contains some references to the lethal doses of x-rays for mice, but because of different conditions of investigation little of this material is comparable with that presented in this communication. As early as 1906, Krause and Ziegler (12) stated that "the lethal dose of x-ray for mice is obtained when the malpighian bodies of the spleen are entirely destroyed. In this case the damage done to the lymph nodes and to the bone marrow is of such a nature that recuperation of the blood-forming tissue is precluded." The ob-

body irradiation in mice was made in 1912, when Meyer and Ritter (15) tried to build up a "mouse unit" as a biologic measure in radiology analogous to the "frog unit" used in the assay of digitalis preparations in experimental pharmacology. Even though their data are in no way comparable, because of the uncertainty of the irradiation factors, their results are interesting. They showed that with increasing doses of x-rays there was a steadily decreasing latent period between the time of exposure and the earliest occurrence of death. They also demonstrated that, as the dose of x-rays was increased, the average life span of the 20 mice exposed to each dose decreased. Increasing the dose of x-rays beyond that



which killed all 20 animals within fourteen days, they were able to show further acceleration of the processes leading to death of the irradiated animals, so that with the highest doses applied, all died within three days.

Investigations performed under well defined conditions of irradiation have confirmed these early observations. Sugiura (17) irradiated mice with x-rays generated at 200 kv., 30 ma., with 0.5 mm. Cu and 1.6 mm. Al filtration. He found that 1,000 r in air killed 12 mice within eight days and 1,500 r given to a total of 8 mice killed 2 on the third, 4 on the fourth, and the remaining 2 on the fifth day. Further increase of the dose, up to 2,830 r, resulted in the death of 2 mice on the third day and of the remaining 6 mice exposed to this dose on the fourth day. Similarly, Goldfeder (11) observed that mice exposed to 4,000 r in air (factors: 200 kv., 6 ma., 1.0 mm. Al filtration) died within four or five days.

Recent studies by Barnes and Furth (6) confirm these observations. These authors irradiated mice with doses ranging from 800 up to 6,000 r in air (factors: 200 kv., 15 ma., 3.0 mm. Al filtration, distance 25 cm.; or 200 kv., 15 ma., 1.0 mm. Cu and 1.0 mm. Al filtration, distance 50 cm.). Study of the bone marrow of the irradiated animals showed that "the larger the dose, the earlier was the decrease of hemopoietic cells in the directly irradiated marrow."

These observations of a shortened latent period and life span following an increase in dose over the ALD are important, for they seem to reveal a species difference between mammals and fish, since in our previous studies with goldfish (8) increase of the ALD of 1,500 r in air up to 10,000 r shortened neither the latent period nor the life span.

Lawrence and Tennant (13) obtained data on the ALD for mice irradiated with x-rays under defined conditions (factors: 200 kv., 0.2 mm. Cu and 1.0 mm. Al filtration). They found that 14 mice died within fourteen days after exposure to 704 r in air. After exposure to 1,000 r in air,

10 mice died within eight days. The mice had been exposed in flat cardboard boxes.

Clarkson, Mayneord, and Parsons (7) irradiated 20 mice with 1,200 r in air (factors: 150 kv., 4.0 ma., 0.3 mm. Cu filtration). The animals died within five days, exhibiting severe diarrhea. Out of 10 mice exposed to 1,000 r, 4 died within eleven days. For irradiation the animals were placed in a wooden box, the lid of which was 9 mm. thick, for which an allowance of 4.5 per cent in absorption was made.

Tang (18) irradiated an unstated number of mice with doses of 500, 700, and 800 r in air (factors: 200 kv., 4 ma., 0.5 mm. Cu filtration). Of the mice exposed to 500 r, 80 per cent survived sixty days, while all of the mice exposed to 700 r died within fourteen days, and those exposed to 800 r within nine days.

Further data of interest have been reported by Liu, Snyder, and Enders (14). These authors irradiated 63 mice in metal containers. The dose was 500 r in air (factors: 200 kv., 8 ma., 0.5 mm. Cu filtration) and 22 per cent of the mice died within fourteen days.

Sugiura (17) found that 750 r in air killed 16 animals within eighteen days, while 1,000 r in air killed 12 within eight days. In his paper, some data on the MLD are also contained. He found that after exposure to 350 r in air all 12 exposed animals survived, while irradiation with 400 r caused the death of 2 out of 22 animals on the fourteenth day, and of one each on the twentieth and twenty-fifth days after exposure.

Further observations on the MLD are contained in the thesis of Wagner (19), who irradiated mice with doses of 275 and 330 r in air (factors: 200 kv., 2.8 ma., 5.0 mm. Al filtration, HVL 0.37 mm. Cu, distance 46 cm.). While a dose of 275 r appeared entirely harmless, the application of 330 r caused the death of some mice.

Lawrence and Tennant (13) found that mice exposed to 400 r in air survived, while after application of 450 r one of 10 mice died within eleven days.

The recent observations of Barnes and

Furth (6) concerning the effect of doses between 100 and 1,000 r in air on the leukocyte level of the blood of mice after total body irradiation are of great interest with respect to studies on the MLD. The graphic presentation of their results shows that "the number of leukocytes in the circulating blood decreases in direct proportion to the dose employed. With larger doses the drop in leukocytes is evident one day after irradiation and reaches its maximum approximately six days after exposure with a gradual return to normal or above normal if the animals survive." They state, furthermore, that "mice almost invariably die following exposure to 1,000 r." Since their graph shows that within twenty days after exposure to 200 r restoration of the leukocyte level to values above normal takes place, these studies are an interesting confirmation of and supplement to our own studies on the MLD and ALD for mice as reported in this paper.

We should now consider the question of the *minimum effective dose* (MED). Careful studies in this field have recently been published by Nettleship (16). He exposed C3H mice to 50 r in air (factors: 200 kv., 20 ma., 0.5 mm. Cu and 1.06 mm. Al filtration, 105.3 cm. distance; intensity 8 r per min.), which produced the following tissue changes: (a) swelling and eosinophilic staining of the cell cytoplasm with reduced nuclear staining; later slight hyperchromia of the cell nucleus and final return to normal; (b) destruction of cells within the lymph node follicles, followed by a mild hyperplasia; (c) an altered blood picture consisting of momentary leukocytosis turning within eight to twelve hours into a mild but persistent lymphopenia. These changes, Nettleship concludes, "represent only small deviations from the normal and they may be regarded as threshold irradiation effects."

In summary it can be said that, with due allowance for the variety of irradiation conditions and the small number of animals used in some recorded experiments, the data presented in this paper seem to be well supported by observations in other

quarters. The review of the literature clearly emphasizes, however, the necessity of standardized irradiation conditions for studies along this line. In order to secure universally applicable data it seems to be necessary, *first*, to use a highly penetrating radiation in order to accomplish homogeneous distribution of radiation throughout the entire animal body; *second*, to irradiate with full utilization of back-scatter.

Observation of this second postulate is necessary to make studies in different animal species comparable. Since a small animal offers a smaller scattering medium than is the case with a larger, omission of this consideration may introduce an error in the evaluation of lethal dose studies, where animals of various sizes are used. It is for this reason that we have included rice bags as a scattering medium in our standard procedure.

### Summary

A standard set-up for the determination of lethal doses of x-rays in mammals has been described. Mice have been used as a test object. As in previous studies with goldfish, an increasing mortality rate has been found with increasing doses of x-rays.

Under the described experimental conditions, the minimal lethal dose (MLD) for radiation of HVL 1.25 mm. Cu has been found to be 200 r in air, and the absolute lethal dose (ALD) 1,000 r in air.

Correlation of the lethal effect of x-rays with the destruction of the malpighian bodies of the spleen has been demonstrated.

The relationship between doses of x-rays and lethal effect in mice has been found to follow an S-shaped curve, similar to that obtained in investigations with goldfish.

The importance of a standard procedure for studies on the lethal effect of x-rays in laboratory animals is discussed.

### III. INFLUENCE OF BACK-SCATTER ON LETHAL DOSE FOR MICE

Mention has been made above of the importance of back-scatter for accurate

lethal dose determination. The investigations about to be reported were therefore undertaken to obtain some information concerning the extent to which scattering influences the lethal dose of x-rays for mice under the conditions previously employed.

*Technic:* The radiation factors were the same as those used in determining the lethal dose (see page 126) and the set-up was the same except that rice bags were not used. Doses ranging between 400 and 1,500 r in air were given in one session.

gressive destruction of the malpighian bodies of the spleen. The spleen of a mouse dying on the sixth day after exposure to 1,500 r in air was almost completely devoid of malpighian bodies, while that of an animal dying on the tenth day after exposure to 800 r (maximum lethal rate 36 per cent) showed definite remnants of malpighian bodies. The spleen of a mouse surviving an exposure to 800 r in air for seventy-seven days appeared normal.

*Relationship between X-Ray Doses and Mortality Rate:* For the study of the lethal

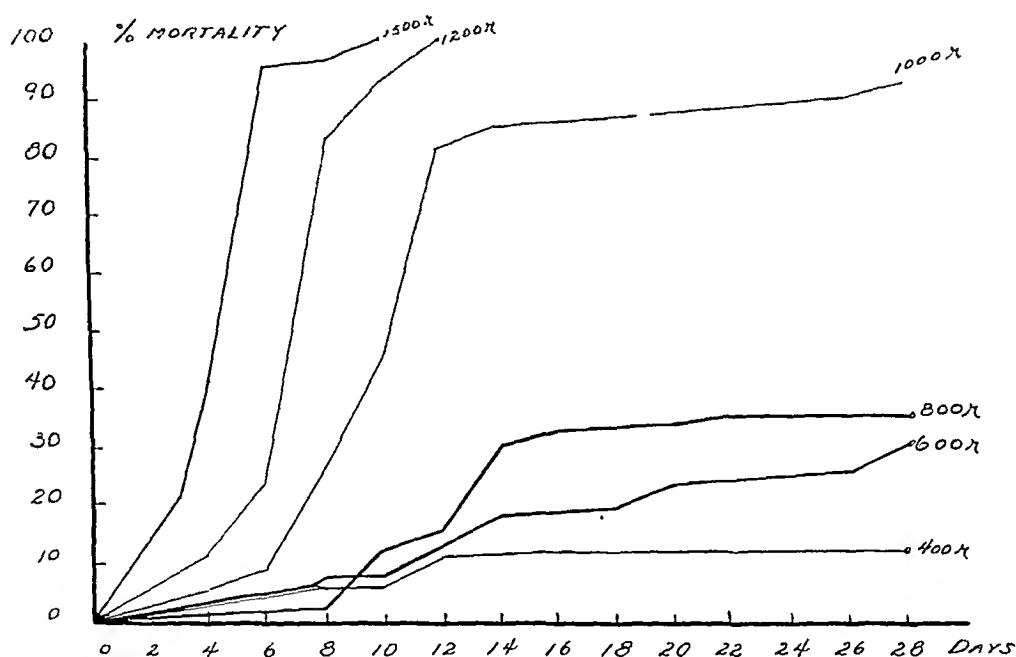


Fig. 12. Lethal dose curves for mice irradiated free in air.

A total of 155 white male mice were used, 36 of which served as unirradiated controls.

*General Appearance of Irradiated Mice and Postmortem Examinations:* As in the previous investigations, there was a latent period of from two to five days (depending on the dose) before any change in the behavior of the mice was noticed. Their general appearance was exactly the same as in the preceding series.

The autopsy findings did not differ from those described above. Grossly the changes in the spleen, small intestine, and stomach were the most conspicuous. Histologic examination revealed the same pro-

effects of x-rays, 18 mice were exposed for each dose except for the dose of 1,000 r in air, where 22 mice were used. The number of dead animals was recorded daily up to the twenty-eighth day. No mortality was observed among the unirradiated controls within this period.

A graphic presentation of the results thus obtained is given in Figure 12. As in the previous investigation, the abscissa denotes the days after exposure, while the ordinate denotes percentage mortality. With increasing doses, from 400 up to 1,200 r in air, the mortality increased accordingly. Further increase of the x-ray dose

up to 1,500 r in air produced a shortening of the latent period and acceleration of the processes leading to death. While the first death occurred on the third day after exposure to 1,200 r in air, and all animals died within eleven days, exposure to 1,500 r shortened the latent period to two days, and all the animals were dead within nine days. In conformity with the previously adopted designation, 400 r in air represents in this series the minimum lethal dose (MLD), while 1,200 r in air is the absolute lethal dose (ALD).

Figure 13 is the mortality curve for mice

where the irradiation took place on top of the rice phantom, while the solid line represents the mortality curve for mice irradiated without the use of rice bags (irradiated free in air). As can be seen, the addition of a scattering medium significantly influences the lethal doses expressed as r in air. This was to be expected. Withdrawal of the rice phantom shifts the ALD from 1,000 r in air to 1,200 r in air, and the MLD from 200 to 400 r in air. While the LD<sub>50</sub> with the rice phantom is about 500 r in air, after withdrawal of the rice phantom about 900 r in air are re-

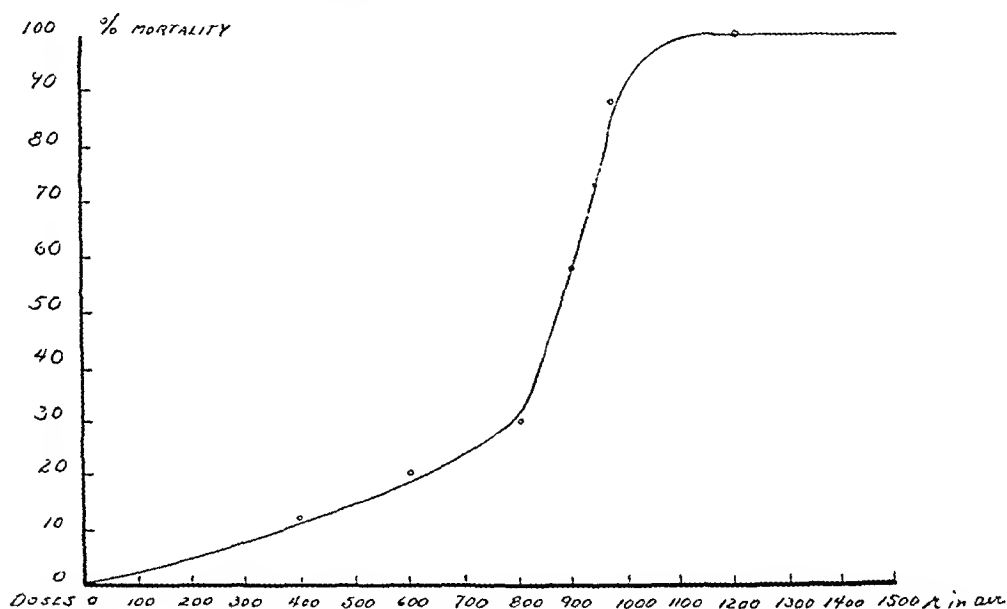


Fig. 13. Mortality curve for mice irradiated free in air.

irradiated free in air for the fourteenth day after irradiation, obtained by plotting on the abscissa the doses of x-rays and using the percentage mortality as ordinate values. As can be seen, the relationship between dosage and mortality follows an S-shaped curve.

*Assay of the Influence of Back-Scatter on the Lethal Dose:* For the determination of the influence of the scattering medium (rice bags) on the lethal effect in mice, Figure 14 was prepared. In this graph the ordinate shows percentage mortality, while the abscissa values are r in air. The broken line represents the mortality curve as obtained in the previous investigations,

required to produce a mortality rate of 50 per cent within fourteen days.

### Discussion

The importance of scattered radiation for depth- and for surface-doses in roentgen therapy is generally recognized. The biologic significance of this physical phenomenon has been extensively studied on the skin and in isolated plant and animal cells (21). A comparative study made by Henshaw and Francis (22), using radiation generated at 200 kv., shows that the percentage of effect produced by irradiation free in air as compared with that on the surface of a paraffin phantom under

the same conditions of irradiation might vary from 10 to 68 per cent for different test objects.

As far as we know, the data presented in this paper are the first to demonstrate the part which back-scatter plays in the irradiation of an entire animal.

The work of Packard (24) with *Drosophila* eggs and that of Sugiura (26) with tumor fragments have shown a definite parallelism between estimation of the back-scatter by ionization measurements and biologic assay. No attempt has been made to correlate our data with ionization meas-

Committee of the Radiological Society of North America (27), which states that to prevent dosimetric errors in radiation therapy due to insufficient depth of underlying tissue, the necessary scattering medium must be artificially provided. The suggestion made by the Committee is that the "total thickness of material (including tissue, the additional material provided, the mattress and wood top of the treatment table immediately underneath) in the x-ray beam beyond the place at which the dose is to be determined should be at least 8 cm."

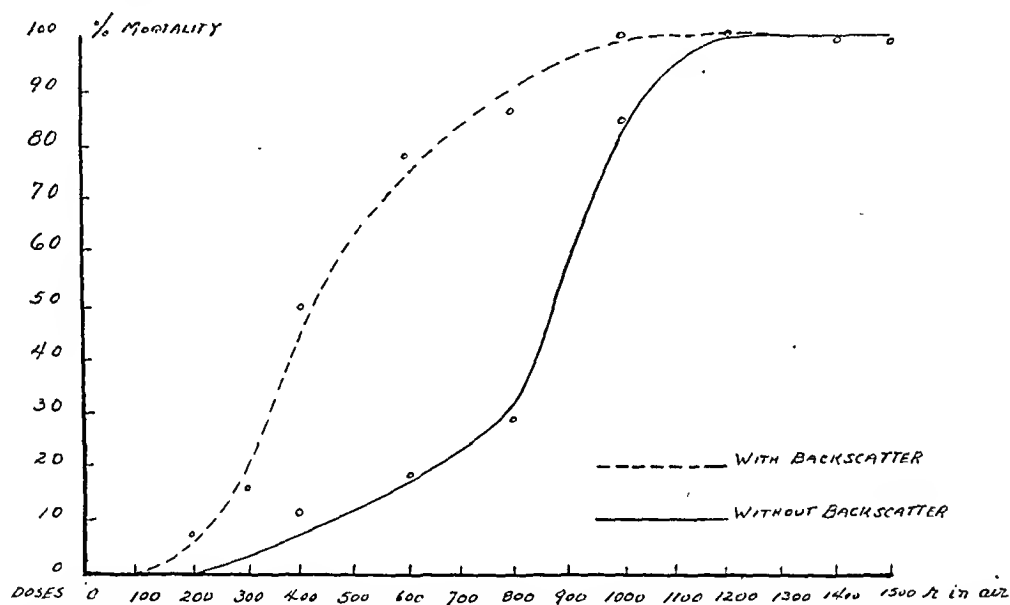


Fig. 14. Mortality curves for mice irradiated on top of rice bags (broken line) and irradiated free in air (solid line). Comparison of these curves clearly demonstrates the influence of the addition of a scattering medium on the lethal effect of x-rays in mice.

urements, because no such an agreement between biologic assay and physical measurements as has been found for these comparatively small objects can be expected when a test object the size of a mouse is used.

The significance of our data seems to be twofold:

(1) They support our previous contention that provision for full use of back-scatter is necessary in the study of radiation effects in total body irradiation of experimental animals.

(2) They give further experimental support to the rule of the Standardization

Rice, which was used in our experiments to build up the necessary depth, is recommended by the Committee for this purpose, because, according to studies carried out by Jacobi and Liechti (23), the back-scatter produced by water and that from rice agree very closely with each other and with the values obtained from animal and human tissues. These results have been confirmed by Quimby and her associates (25).

Since the nature of scattered radiation depends at least in part on the chemical composition of the scattering medium, some of the contradictions in the results of

previous investigators in the field of lethal dose determination in total body irradiation seem to be explained. Obviously these discrepancies will be greater in smaller mammals than in the larger species which, because of their greater mass, provide sufficient or almost sufficient scattering media. In order to obtain conditions of irradiation which are universally applicable in experimental radiation therapy, the inclusion of a well defined scattering medium of sufficient depth in the irradiation set-up appears to be in-

data be obtained concerning lethal doses for smaller laboratory animals.

Rice bags, already in use for the purpose of providing additional back-scatter in radiation therapy, are suggested as a suitable means for such a standard set-up in experimental studies.

#### IV. DETERMINATION OF LETHAL DOSE FOR GUINEA-PIGS

Earlier in this paper a method for the determination of the lethal dose of x-rays for small mammals (mice) was presented

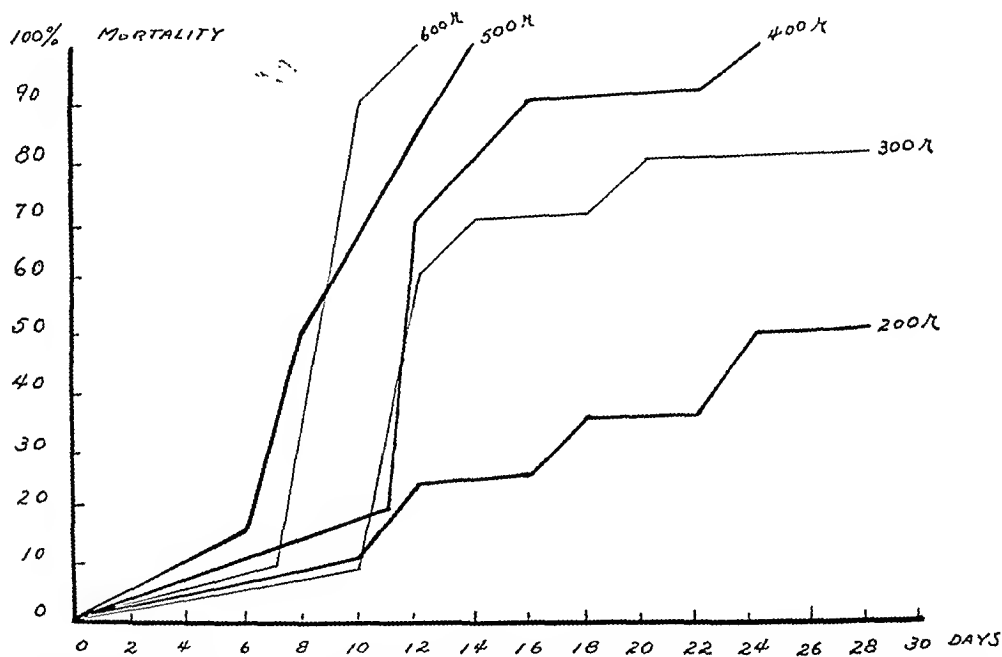


Fig. 15. Lethal dose curves for guinea-pigs. The mortality increased progressively as the doses were raised from 100 to 500 r in air. Increases over 500 r in air did not increase the mortality rate.

licated by our experimental data. Rice bags seem to be most convenient for this purpose.

#### Summary

Experimental data showing the influence of back-scatter on the lethal effect of x-rays (HVL 1.25 mm. Cu) in total body irradiation of mice are presented.

The importance of the inclusion of a well defined scattering medium of sufficient depth to provide maximum back-scatter in the irradiation set-up is outlined, and it is explained that only by adopting this procedure can universally comparable

(page 126). In a further series of experiments the same method was applied to a larger animal. The guinea-pig was chosen as the largest animal which could be used without a fundamental change in the conditions of irradiation.

*Technic:* The radiation factors were those previously used (page 126). The doses ranged from 100 to 600 r in air and were given in all instances in one continuous exposure.

A total of 55 guinea-pigs, all males, were used, 6 of which served as unirradiated controls. The weight of the animals varied between 400 and 550 gm. For each ex-

posure 2 animals were placed in linen bags on top of the rice phantom, as described above (page 126).

*General Appearance of Irradiated Guinea-Pigs:* For six to eight days after exposure (depending on the dose) the appearance of the irradiated animals differed in no way from that of the unirradiated controls. After this latent period some of the animals suddenly exhibited severe dyspnea and died within a few hours. When the first fatalities occurred, the rest of the animals of the same lot usually showed ragged fur, loss of appetite, and diarrhea. Depending on the size of the dose, some recovered and within twenty days their appearance was almost the same as that of the controls.

*Postmortem Examinations:* The postmortem examinations revealed severe injury to the blood-forming tissues. These changes were most conspicuous in spleen and bone marrow. With increasing doses of x-rays, atrophy and shrinkage of the lymphatic tissues increased. Histologic examination revealed progressive depletion of lymphatic elements in the sternal bone marrow and spleen, in direct proportion to the doses employed. As in mice, the malpighian bodies of the spleen permitted some quantitative evaluation of the radiation effect. In a guinea-pig which died on the twelfth day after exposure to 200 r in air, the malpighian bodies were still present. There was a decrease in lymphocytes, with increase in fibrous tissue and red blood cells. The bone marrow showed considerable depletion of white elements. In surviving animals killed on the sixtieth day after exposure, both bone marrow and spleen were entirely normal in appearance. The spleens of guinea-pigs which died on the twelfth day after exposure to 400 r in air showed only small remnants of lymphatic elements and a very considerable increase in fibrous tissue. Much hemosiderin was found in the spleens of these animals. The bone marrow showed a still greater depletion of white elements. The spleen of an animal which died on the twenty-fourth day after exposure to 400 r in air was hyperemic;

the malpighian bodies were indistinctly outlined. The bone marrow was crowded with immature blood cells; the majority were megakaryocytes, but myelocytes were only rarely found. The most pronounced destruction was seen in an animal which died on the eighth day after exposure to 600 r in air. Here practically no malpighian bodies could be discovered in the hyperemic spleen; only here and there some white elements were present. The bone marrow was almost devoid of white cells.

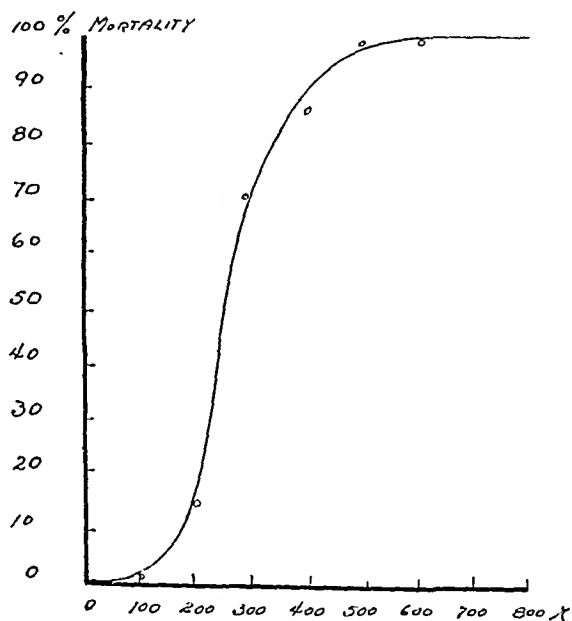


Fig. 16. Mortality curve for guinea-pigs, fourteenth day after exposure to x-rays.

Besides these findings in spleen and bone marrow, there were frequent hemorrhages in the lungs and severe mucosal hemorrhages in stomach and duodenum. Most interesting was the observation of fatty degeneration in the livers of some animals, with definite arrangement of the fat around the central vessels. A detailed discussion of these findings will be given in a later paper.

*Relationship between Doses of X-Ray and Mortality:* The relationship between doses of x-ray and mortality is presented in the form of lethal dose curves (Fig. 15). As can be seen, with increasing doses, up to 500 r in air, the percentage mortality



increases. Thus, 500 r represents the absolute lethal dose (ALD) in this instance.

In accordance with the procedure employed in the experiments with mice, the mortality curve for guinea-pigs exposed to x-rays under our standard conditions of irradiation has been constructed. As can be seen from Figure 16, the relationship between doses of x-rays and the lethal effect in guinea-pigs is expressed by an S-shaped curve.

### Discussion

*General Discussion:* The data presented above demonstrate that the method of

cm. distance). Of the 36 animals, 33 or about 90 per cent died within twelve to fourteen days. Woenckhaus and Münzel (32) irradiated a small number of guinea-pigs, using 185 kv., 0.5 mm. Cu and 1.5 mm. Al filtration, and a distance of 30 cm. A dose of 145 r in air produced a severe drop in the leukocyte count three hours after exposure, followed by a rise, the so-called *poussée leucocytaire* of Aubertin and Beaujard (28). Beginning with the second day a leukopenia developed, with a final return to normal. No fatalities were recorded. The first fatalities were observed

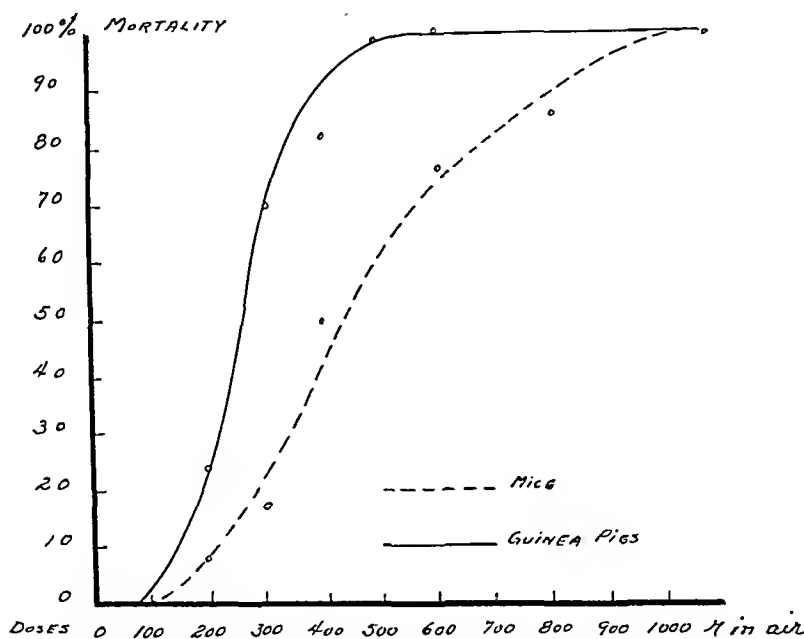


Fig. 17. Mortality curves for mice (broken line) and for guinea-pigs (solid line), fourteenth day after exposure to x-rays. The much steeper slope of the curve for guinea-pigs is of interest as a possible expression of species specificity.

lethal dose determination evolved from studies of small mammals can be applied to larger animals. Our data are in close agreement with the findings of previous investigators, in spite of different methods.

Fabricius-Moeller (30) stated that 7 or more Holznecht units invariably killed guinea-pigs within thirteen days. This dose corresponds to about 70 per cent of a skin erythema dose, or roughly 420 r in air. Jugenburg (31) irradiated 36 guinea-pigs with half a skin erythema dose, or approximately 300 r in air (factors: 200 kv., 0.5 mm. Zn and 3.0 mm. Al filtration, 40

after exposure to 290 r in air, while doses of 435 and 580 r invariably produced death.

*Comparison of Results with Those Obtained in Mice:* It is interesting to note that, corresponding to the observations on mice, as the absolute lethal dose for guinea-pigs was approached, increasingly destructive effects in the blood-forming tissues were observed. When the ALD was reached, complete destruction of the malpighian bodies of the spleen was noted.

It is of interest, also, that in guinea-pigs the latent period between exposure and occurrence of the first fatalities was nearly

twice as long as in mice. Depending on the dose of x-rays used, the latent period in guinea-pigs varied between six and eight days, the corresponding period for mice ranging from two to six days. Even with administration of about three times the ALD, this prolonged latent period was observed in guinea-pigs. According to Clarkson, Mayneord, and Parsons (29), all of 6 guinea-pigs exposed to 1,500 r in air (factors: 150 kv., 4 ma., 0.3 mm. Cu inherent filtration) died on the fifth day after exposure.

The much steeper slope of the mortality curve of guinea-pigs seems to merit attention. Figure 17 clearly demonstrates this difference in the two species.

Both observations, the prolonged latent period and the steeper slope of the mortality curve of guinea-pigs, may be considered as an expression of species specificity. It is also of interest to note that the life span of the guinea-pig is approximately double that of the mouse.

Summary

The applicability of a method for the determination of lethal doses of x-rays derived from the study of mice has been demonstrated for a larger animal, the guinea-pig.

With increasing doses of x-rays, an increase in the percentage mortality was found up to 500 r in air. This dose represents the absolute lethal dose (ALD) for guinea-pigs under our conditions of exposure.

As in mice and goldfish, the relationship between dose of x-rays and percentage mortality is expressed by an S-shaped curve.

Comparison of the mortality curves of mice and guinea-pigs shows a steeper slope of the curve for guinea-pigs. In connection with some observations concerning the latent period, this is considered to be an expression of species specificity.

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# Foreign Bodies in the Digestive Tract<sup>1</sup>

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FOREIGN BODIES in the digestive tract are a not infrequent finding. Usually they give no trouble, simply making their way out through the natural passages. It is indeed surprising that objects of considerable size and unusual shape, including open safety pins, manage to pass through the esophagus, stomach, and bowels without producing any injury to these structures. An interesting example is the case of a man who swallowed a complete upper denture. The object was followed fluoroscopically as it passed through the entire alimentary tract until it was recovered and was eventually restored to its natural habitat, the mouth. The patient was none the worse for his unusual experience.

Foreign bodies in the digestive tract may be classified in four groups depending upon the degree of resistance to x-ray penetration.

(1) Opaque foreign bodies, usually metallic, are the most resistant and are readily recognized in the roentgenogram.

(2) Semi-opaque foreign bodies, including bone fragments and any substance containing calcium, offer only partial resistance. Their demonstration depends upon their size and location.

(3) Non-opaque foreign bodies, possessing the same resistance as the surrounding tissue, can be recognized only by indirect measures, as the introduction of an opaque fluid substance.

(4) Translucent foreign bodies of low density, such as fat masses, exhibiting less resistance than the adjacent tissues, are recognized by the so-called negative shadow.

In general it may be said that any foreign body that becomes lodged anywhere in the alimentary tract is a source of serious

danger because of possible obstruction, perforation, or abscess formation. It is, therefore, quite apparent that a diagnosis must be established as soon as possible in order to enable the surgeon to remove the foreign body before complications set in.

Several cases have been selected to illustrate the four groups of foreign bodies and the particular technique applied in their demonstration. Since the site of lodgment determines the type of technique to be used, the discussion will follow anatomical lines.

## THE CERVICAL ESOPHAGUS

The cervical portion of the esophagus is the most frequent site for the lodgment of foreign bodies. This is to the advantage of both roentgenologist and laryngologist, because of the relative ease in making an accurate diagnosis and the accessibility of the foreign body for removal.

A lateral view of the neck is obtained at 6 feet distance, with the cassette placed against the shoulder. Such a roentgenogram will show all the cervical vertebrae and soft structures of the neck.

A study of the lateral roentgenogram of the neck will reveal three parallel columns of varying degrees of density. The posterior column, the densest, is formed by the bodies of the cervical vertebrae. The anterior column is translucent and represents the air-containing trachea. The middle column is semi-opaque and is the narrowest one of the three, representing the cervical portion of the esophagus (Fig. 1). Except in infants this relationship appears to be constant regardless of sex, height, weight or habitus. Whenever the diameter of the middle column exceeds that of either of the other two, the possibility of a foreign body should be considered, especially in the presence of a suggestive history. This widening of the retrotracheal space may be due to the bulk of the foreign body, to swell-

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.



Fig. 1. Lateral roentgenogram of the neck, showing three parallel columns. Except in infants, the middle or retrotracheal column, containing the cervical portion of the esophagus, is normally the narrowest of the three.

ing of the esophageal mucosa, or to a formed abscess.

The presence of a foreign body without widening of the retrotracheal space (Fig. 2) indicates that the accident is of recent occurrence, since not enough time has elapsed to produce a reaction in the tissue, with characteristic swelling of the mucosa. On the other hand, if the space is widened and it is known that the accident was of recent occurrence, the probability is strong that the widening is due to the bulk of the foreign body. An illustrative case is that of a man who was examined only two hours after the accident (Fig. 3, A). A minute fragment of bone was observed, which was obviously not responsible for the widening. Upon ingestion of a single mouthful of a barium mixture, the enlarged retrotracheal space was found to be mottled, the mottling apparently representing the outline of a soft-tissue mass comprising the bulk of the foreign body (Fig. 3, B). This inter-

pretation was confirmed by the removal of fragments of meat.

In the presence of a foreign-body shadow in the esophagus, the introduction of an opaque mixture appears to be an unnecessary procedure. Its use should be reserved for doubtful cases or cases where no opaque body is demonstrable. It must be ab-



Fig. 2. Fragment of bone at the root of the neck. The middle column is not widened, indicating absence of complications.

solutely avoided if the foreign body is in the stomach or intestines, for it may then obscure the mass.

When the widening of the retrotracheal space is due to swelling of the mucosa, the case is usually of several days' duration. Figure 4 illustrates a case in which the patient failed to consult a physician for several days after the accident. A lateral teleroentgenogram of the neck showed widening of the retrotracheal space and, within the swelling, an indistinct linear shadow of only slight opacity. Notwithstanding the positive diagnosis of a foreign body, the surgeon could not locate it. Only



Fig. 3. A. Roentgenogram made two hours after the swallowing of a foreign body. The middle column is widened, containing a minute fragment of bone. B. Roentgenogram of same patient, made after ingestion of barium. The mottled appearance is due to fragments of meat.



Fig. 4. Widening of retrotracheal space due to swelling of mucosa, with an indistinct shadow of a bone fragment swallowed several days earlier.

Fig. 5. Widening of retrotracheal space, with a fish-hook-like shadow due to a fragment of bone. The foreign body was obscured by the swollen mucosa.



Fig. 6. Large swelling of retropharyngeal and tracheal space due to an abscess. Note the shadow of a bone fragment and gas bubble indicative of perforation.

upon a second trial several days later was it located and removed. The first failure was obviously due to the greatly swollen mucosal folds that hid the object from view.

The serious consequences of delay in consulting a physician are illustrated by the case of a man who swallowed a chicken bone which apparently became lodged at the root of the neck. The physician was not called until symptoms of suffocation developed, about four days after the accident. The patient was immediately transferred to the hospital and a tracheotomy was performed. On the following day an x-ray examination of the neck revealed widening of the retrotracheal space with a fish-hook-like shadow of moderate density in the widened area. There were also several irregular translucent areas, but whether these were air bubbles resulting from perforation or from the tracheotomy was difficult to determine (Fig. 5). Attempts to remove the bone fragment were made, but it could not be located. The condition became complicated by abscess

formation requiring an operation. The patient finally succumbed, and at necropsy the bone fragment was found deeply embedded in the swollen mucosal folds.

The following case illustrates the serious results which may occur when a general practitioner assumes the responsibility of determining the presence or absence of a foreign body. A patient, soon after having swallowed a piece of bone, consulted a physician, who made a fluoroscopic examination of her neck and assured her that there was no sign of a foreign body. (Parenthetically it may be said that roentgenologists who are skillful with the use of the fluoroscope do not have the temerity to draw positive conclusions as to the absence of a foreign body without the aid of roentgenograms.) After several days the patient's condition grew worse and she was then referred to an otolaryngologist. A roentgenogram of the neck revealed marked increase in the width of the retropharyngeal and tracheal spaces. Within the swelling a fragment of bone and a bubble of gas (a pathognomonic sign of perforation) were observed (Fig. 6). The diagnosis of an abscess was quite evident, but attempts at operation failed to save the life of the patient.

In examining the neck for possible foreign bodies, one should also pay attention to translucent shadows. Figure 7, A, is a roentgenogram showing widening of the retrotracheal space, within which is an indistinct shadow of a fragment of bone and above this a translucent area. In order to differentiate between a bubble of gas in the esophagus and a piece of tissue of low density, a teaspoonful of lipiodol was given. Instead of displacing the translucent shadow, as would happen if it were free air, the lipiodol appeared to encircle it (Fig. 7, B), proving it to be tissue of low density, namely fat. This was confirmed by the removal of the foreign body.

#### THE ESOPHAGUS WITHIN THE THORACIC CAGE

Only foreign bodies of dense consistency can be directly demonstrated in the esopha-



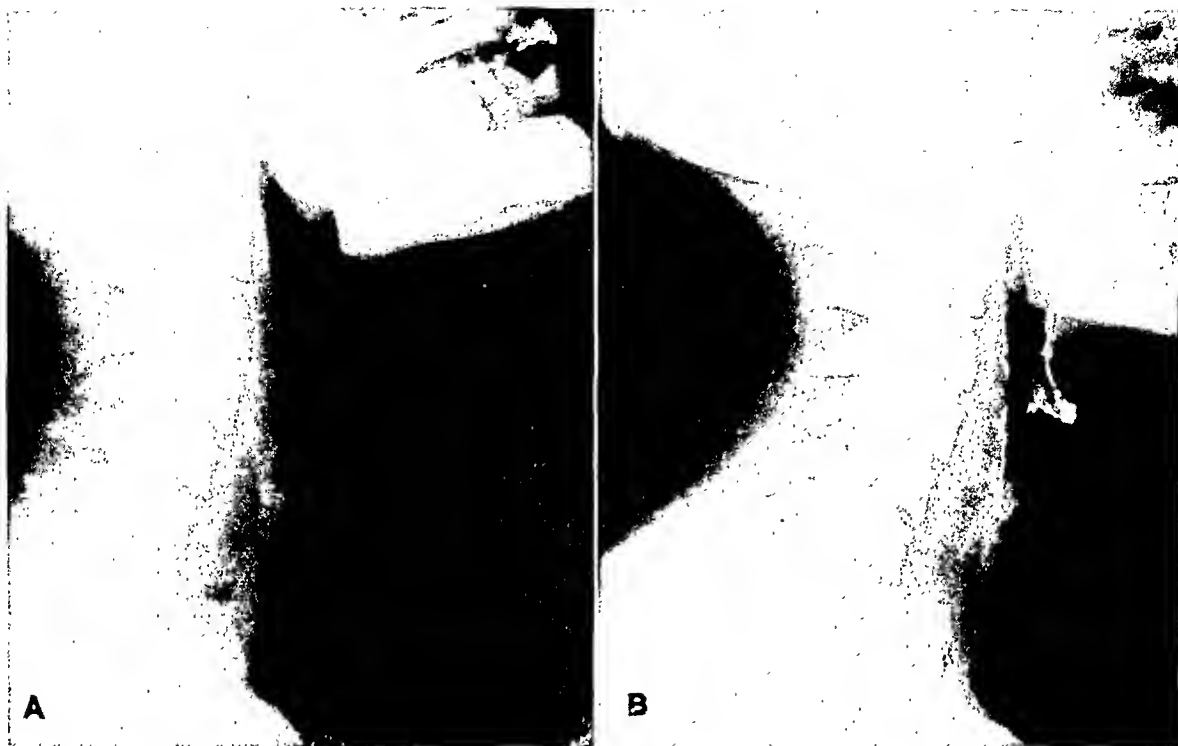


Fig. 7. A. Retrotracheal swelling with translucent shadow and indistinct fragment of bone. B. Roentgenogram made after ingestion of lipiodol. The translucent shadow remains, indicating that it is due to fat and not to a bubble of gas.

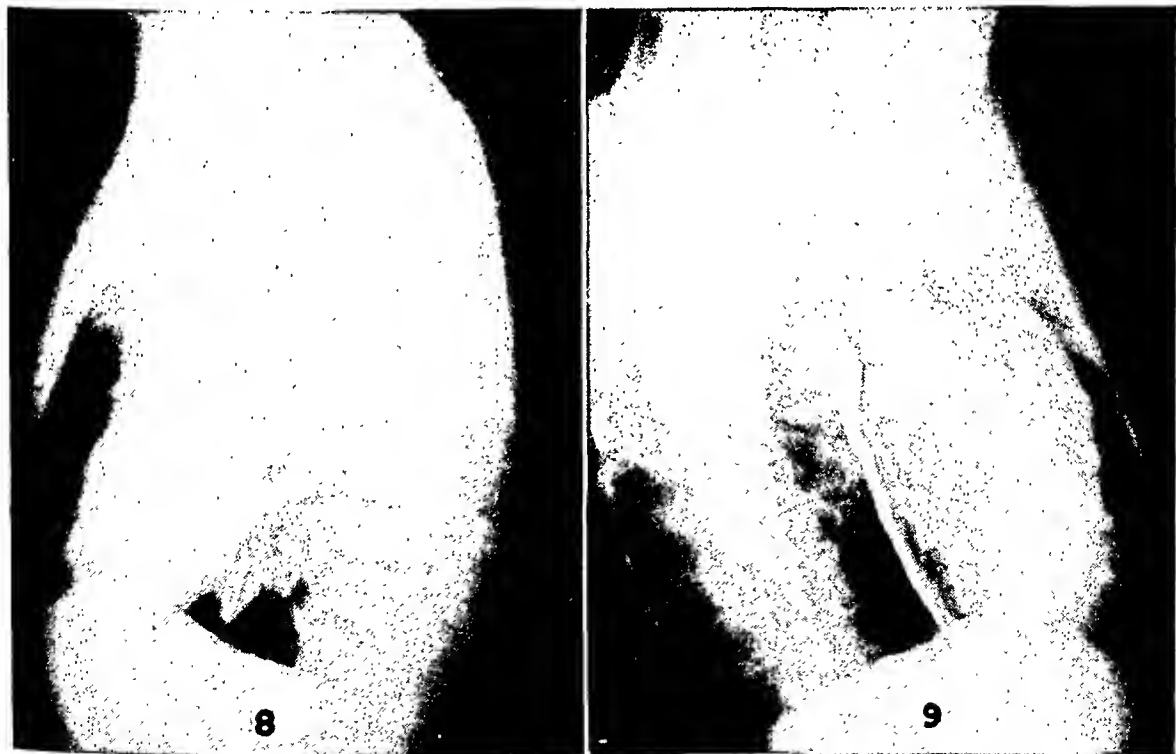


Fig. 8. Dense shadow due to a fragment of bone in the esophagus, present for several months.

Fig. 9. Bifurcation of barium column, due to a fragment of bone below the aortic arch.



Fig. 10. Abrupt stoppage of the barium column about two inches above the cardiac end of the esophagus, due to a plug of meat.



Fig. 11. Hairpin at the pyloric end of the stomach, penetrating its wall. The open ends are embedded in the head of the pancreas.

gus within the thoracic cage, and then only in the lateral projection. Semi-opaque or non-opaque foreign bodies can be diagnosed only after the ingestion of an opaque mixture.

The following case, illustrating a dense foreign body in the esophagus, is interesting from several angles. While partaking of a chicken dinner, the patient experienced a painful sensation deep in the chest. He immediately consulted a physician, who appears to have disregarded the history, treating the patient for several months for digestive disturbances. Having failed to respond to the treatment, the patient was advised to consult a gastro-enterologist. He carried out the usual procedures in the examination of the gastro-intestinal tract, including a complete x-ray examination by a competent roentgenologist, who concluded that a duodenal ulcer was present. The patient was treated accordingly, but failed to respond. After several weeks, he

was referred to an otolaryngologist for examination of the esophagus, evidently as a result of greater attention to the clinical history. Upon fluoroscopic and roentgenographic examination at this time a dense shadow was observed in the region of the esophagus just above the diaphragm (Fig. 8). The patient made a rapid recovery after removal of a fragment of bone.

A second case is that of a woman who presented the usual history of deep-seated pain in the chest after swallowing a chicken bone. A plain view of the thoracic cage failed to reveal positive signs of a foreign body. After ingestion of a small amount of barium mixture, a bifurcation of the current just below the aortic arch was observed (Fig. 9). The diagnosis of a non-opaque foreign body was confirmed by the removal of a tiny piece of chicken bone.

A frequent cause of obstruction of the lower end of the esophagus is fragments of meat. During the course of a beefsteak



Fig. 12. Feeding tube remaining in the stomach for a week.

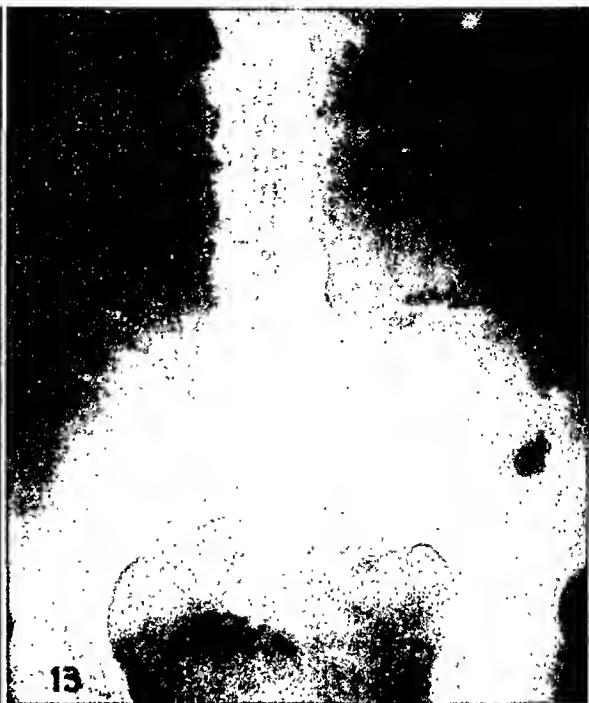


Fig. 13. Gallstone in the small bowel, producing intestinal obstruction.

dinner a patient suddenly felt a pressure sensation deep in the lower region of the chest. He was unable to continue his dinner because of regurgitation of food. A physician was immediately called, but x-ray examination of the chest revealed no unusual shadows. After the ingestion of a barium mixture, an abrupt obstruction was noted about 2 inches above the diaphragm, indicating the presence of a foreign body (Fig. 10). This was removed and was found to consist of a good-sized mass of meat. In general, ordinary food does not seem to fall under the heading of foreign bodies, but when stalled in the passageway, it must be regarded as such and is, relatively speaking, of frequent occurrence.

#### THE STOMACH

Many foreign bodies have been found in the stomach, especially of metallic nature. Their diagnosis is quite simple. The following case is of special interest and merits a more detailed report. The first examination was made by Dr. Nathan Flax because of gastro-intestinal disturbances. X-ray examination of the stomach revealed

a hairpin in the pylorus with the open ends protruding through its wall (Fig. 11). The patient was taken immediately to the hospital and a second x-ray examination confirmed the previous findings. Operation disclosed a rusty hairpin, which had penetrated the pyloric end of the stomach, with the open ends embedded in the head of the pancreas. There was no sign of abscess formation, and the patient made an uneventful recovery. During the interrogation he denied any knowledge of ever swallowing a hairpin. He did admit, however, that, many years before, he had been in the practice of hairdressing.

The use of gastric tubes for various purposes is a common practice, and so long as the outer end is anchored, the tube is not regarded as a foreign body. If, however, it becomes disengaged from its anchor and slips down into the stomach, it immediately comes under that category. Such an instance occurred recently in our hospital. The patient, aged 75, with an extensive carcinoma of the mouth was fed through a gastric tube introduced through the nasal passage. It was anchored to the nose but

unfortunately became loose and was swallowed (Fig. 12). Several attempts were made to remove the tube from the stomach by gastroscopy, but all were unsuccessful. The tube remained in the stomach for a week with no tendency to enter the bowels. More radical measures for its removal were considered, but before they were carried out the patient died of carcinoma.

#### THE INTESTINES

Gallstones are not foreign bodies so long as they remain in the gallbladder, but when they become lodged in the intestines, their action is similar to that of any other foreign mass and serious consequences to the patient may ensue. The following case is one of several coming under observation. The patient was admitted to the hospital because of symptoms of acute obstruction. A plain view of the abdomen revealed moderate gaseous distention of the small bowel, with a dense circular shadow overlapping the left ilium (Fig. 13). The laminated character of the shadow was strongly suggestive of a gallstone. Immediate operation, revealing an obstructing gallstone in the small bowel, confirmed the diagnosis. In not all the cases are the stones so dense as in the present instance, but a careful study of the film in cases of intestinal obstruction may reveal suggestive shadows.

#### SUMMARY AND CONCLUSION

Foreign bodies of whatever nature may prove to be of serious significance when

they are stalled anywhere in the course of the digestive tract. The diagnosis must be made with the least possible delay, in order to prevent such complications as obstruction, perforation, and abscess formation. Roentgen examination has been found to be the most useful method for establishing an accurate diagnosis.

The technic is simple. A fluoroscopic survey should be made of the neck, chest, and abdomen, especially in the case of infants and children. In adults, a lateral view of the neck in the presence of a foreign body will reveal direct or indirect evidence in practically all cases. One should carefully note the width of the retrotracheal space, which is, as a rule, normally narrower than that of the trachea or the bodies of the vertebrae. If the width of the retrotracheal space exceeds that of the trachea or the vertebral bodies, one should suspect the presence of a foreign body even in the absence of shadows of bone fragments.

Most of the foreign bodies in the thoracic portion of the esophagus can be demonstrated indirectly by the introduction of an opaque substance, but first a plain lateral view of the chest should be made and carefully examined in order to avoid obscuring a moderately dense shadow of a foreign body.

Several cases have been selected from a large group, illustrating various foreign bodies in the digestive tract.

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# Atypical Pneumonia with Roentgen and Pathologic Findings<sup>1</sup>

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ATYPICAL pneumonia has been reported as occurring in various Army and Navy organizations, as well as in civilian institutions in the United States, during the last few years. It is probably an old disease, endemic in some localities, assuming epidemic character due either to change in the virulence of the causative agent or an increase in individual susceptibility. The diagnosis is made from the history, physical examination, evaluation of laboratory findings, as smears from sputum or throat washings, animal inoculations and blood cultures, and roentgen examination. The clinical course of atypical pneumonia, possibly of virus origin (1-3), differs somewhat from that of bacterial pneumonias, in that the patient with atypical, non-bacterial pneumonia is not so ill.

No one to date has been able to isolate a causative agent of atypical pneumonia of non-bacterial origin to be found in the majority of cases. It is believed by some workers, however, that parrot fever, ornithosis, or psittacosis is related closely to the disease, if not the direct cause in some instances (4). It seems unlikely that the psittacine virus could be the direct cause of all atypical, non-bacterial pneumonias, as usually the patients with psittacosis are decidedly more ill than the average patient with atypical pneumonia of non-bacterial origin.

The onset in the non-bacterial type of pneumonia is often insidious, with mild coryza and a watery nasal secretion which soon becomes tenacious and at times blood-streaked but not grossly bloody. There is an annoying cough, possibly with substernal pain and malaise, but seldom are there enlarged cervical nodes. The temperature is usually elevated; it may reach

102 or 103° F. but rarely 104° or 105° F. In our series of 91 cases there were 2 with a temperature of 106° F. and 6 reaching 105° F. The temperature dropped by lysis, as a rule, in five to twenty days after the onset of the disease. In this series the majority of patients were fever-free ten days after entering the hospital. Seldom did the temperature fall below 98°. It has been observed by some that in atypical, non-bacterial pneumonia the temperature often drops about the third day. This finding was not particularly in evidence in our series except where it was believed to be due to the effect of one of the sulfa drugs, administered during the preceding twenty-four or forty-eight hours, on secondary bacterial invaders. There was slight, if any, elevation of the pulse or respiratory rate. Rarely did the pulse rate exceed 100. In the majority of cases it was seldom over 80 per minute; in a few it ranged from 80 to 90 per minute. If considerable consolidation developed, the pulse was likely to be rapid. The average respiratory rate was 20 per minute. In a moderate number of patients the rate was from 20 to 30 per minute. In few was it as high as 40 per minute. The following symptoms were frequently present but varied considerably in degree and often were absent: chills, headache, muscle soreness, sweating, expectoration, sore throat, and chest pain.

The average blood counts were as follows for the 91 cases:

	Low	High	Average
Red cells	3,360,000	5,780,000	4,880,000
Hemoglobin	70%	120%	87%
White cells	3,900	23,000	5,500
Neutrophils	50%	90%	72.5%
Lymphocytes	5%	44%	10.9%
Eosinophils	0%	10%	1.6%
Non-segmented cells	6%	56%	24.9%
Large monocytes	0%	25.5%	4.6%

The x-ray findings as observed in our series followed a pattern but were not so constant as to be called characteristic.

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2 1943.



Fig. 1. Roentgenogram showing extremely light pseudopneumonic consolidation in lower lobe of left lung and general increased density of each hilum. This case is one of the three for which autopsy findings are reported.

They could indeed be simulated by various other lung diseases. As a rule, early in the course of atypical pneumonia of non-bacterial origin, a coryza and tracheo-bronchitis developed, with enlarged hilar shadows of light density. The linear markings about one or both hila increased in size. Small areas of light pneumonic or pseudopneumonic density and atelectasis appeared in one or possibly both lungs. The ensuing pneumonic consolidation and atelectasis usually were lobular rather than lobar in character and were most often in but one base rather than bilateral. Local areas of emphysema developed and seldom was there an associated elevation of either hemidiaphragm. This picture differs somewhat from that of total atelectasis with no local associated emphysema at the bases of the lungs seen in bacterial pneumonias. Resolution took place irregularly, starting at the periphery of the lung and advancing into the hilum. This mode of clearing is the direct opposite of that observed in the bacterial pneumonias. The clearing process was not uniform, however, and was frequently erratic. One area of lung was often clearing while

another was consolidating. There were often residual thickening of linear markings, interstitial pneumonitis, and at times small transverse linear areas of atelectasis in regions formerly consolidated, remaining only a few days or, in some cases, several weeks after the patient was otherwise apparently well. The frequency of consolidation occurring in various lobes was as follows: right lower lobe, 29 times; left lower lobe, 23 times; left upper lobe, 10 times; right middle lobe, 8 times; right upper lobe, 7 times; right hilum, 24 times; left hilum, 19 times.

The x-ray picture in general revealed more disease than the physical findings would lead one to believe possible. One could often diagnose a pneumonic process largely by x-ray before the physical findings were sufficiently pronounced to indicate the type of disease present. The diagnosis was made largely by the process of exclusion of other known causes of pneumonia and other lung diseases, and by evaluation of the history and physical findings, laboratory studies, and roentgen examination.

It is known that non-virus pneumonias may be caused by the staphylococcus, streptococcus, influenza bacillus, Friedländer's bacillus, *B. tularensis*, rickettsial agents, and toxoplasma. It is not unusual to find two or more organisms causing a pneumonia and thereby complicating the clinical, laboratory, and x-ray findings, as well as the therapy. A variety of organisms were identified from the sputum in our series of atypical pneumonias, either by direct smears or injections into ferrets and mice. By these methods one obtains valuable information helpful both in diagnosis and treatment. Our findings were as follows:

- Streptococcus viridans* in 11 patients.
- Staphylococcus aureus* in 11 patients.
- Micrococcus catarrhalis* in 9 patients.
- Streptococcus haemolyticus* in 7 patients.
- Haemophilus haemolyticus* in 4 patients.
- Non-hemolytic streptococcus in 4 patients.
- Haemophilus influenzae* in 2 patients.
- Pneumococcus Type XIII in 1 patient (mouse injection).

Pneumococcus Type II in 2 patients (Neufeld reaction).

Pneumococcus Type X in 1 patient (peritoneal exudate from injected mouse).

Pneumococcus Type III in 1 patient (quellung reaction).

Lancet-shaped diplococci in 1 patient (quellung reaction).

Gram-positive cocci

Singly in 2 patients.

In pairs in 2 patients.

In long chains in 1 patient.

In short chains in 2 patients.

Gram-positive bacilli in 1 patient.

Gram-negative bacilli in no patient.

There were no positive blood cultures in this series.

Emphasis should be placed on the importance of an early blood culture, as well as a bacterial analysis of sputum or throat washings, before administration of drug therapy, as bacterial growth, as well as the clinical picture, may be altered by chemotherapy. One should not delay, however, in prescribing the sulfa drugs even before the results of the laboratory tests have been ascertained, thereby avoiding the loss of valuable time in the treatment of the patient. As it is claimed that 86 per cent of all pneumonias are caused by bacteria, four-fifths of which are the pneumococcus types I to VIII, inclusive, it is reasonable to assume that a high percentage of cases treated by sulfa drugs will be benefited, regardless of whether the pneumococcus is present as the direct cause of the pneumonia or as a secondary invader. In our atypical pneumonia series one could usually determine if secondary invaders had entered the picture by the accentuation of the symptoms or the finding of the organism in the patient's sputum or blood.

It is not often possible to find a causative agent from secretions, blood, or sputum, although some virus infections can be reproduced in ferrets and may then be transplanted into mice. The viruses of influenza A and B and also psittacine virus have at times been found in cases of atypical pneumonia.

The influenza virus is virulent in ferrets, which produce antibodies. The disease can thus be definitely identified. Pneu-

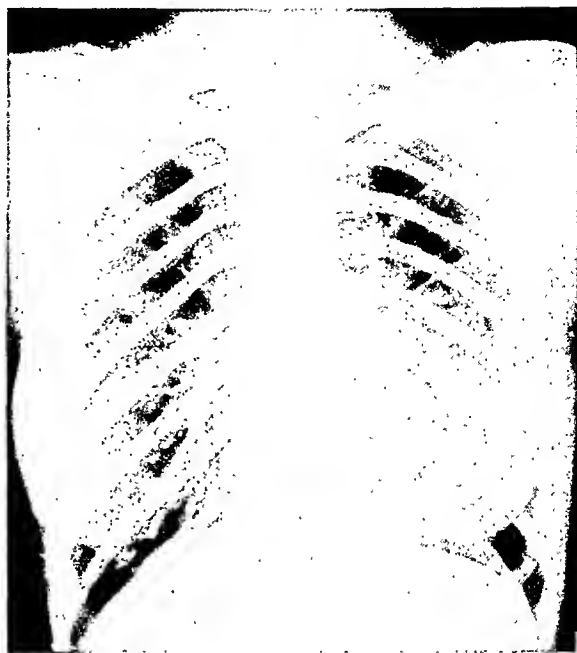


Fig. 2. Light-density pseudoconsolidation seen in the average case of atypical, non-bacterial pneumonia.

monias, at times fatal, are said to be produced by the Rickettsias of typhus fever, Rocky Mountain fever, and Q fever. A very severe and contagious pneumonia occurs from infection with the psittacosis virus. This virus can be recovered from the infected patient's sputum, and a complement-fixation test is specific for the disease. Tularemia may produce pneumonia, *B. tularensis* entering the body during the handling of wild rabbits or other animals. The organism may even enter the lungs by inhalation during the shearing of sheep. The infection causes enlargement of the lymph nodes of the body. The axillary nodes are prone to enlarge when infection occurs through an abrasion of the hand. These nodes are firm and do not respond well to x-ray or other therapy.

Clinically the Friedländer bacillus produces a much more severe pneumonia than the atypical, non-bacterial (virus) type, with chills, fever, rapid respiration, high pulse rate, pain in the chest, often cyanosis, and red non-viscid sputum. No leukocytosis is present, as in pneumococcus pneumonia. The disease terminates fatally.



*Pneumococcus pneumonia* differs from the non-bacterial type (virus) in being very severe, with chills, high fever, and rusty sputum, which is viscid. Both pulse and respiration are rapid. The area of lung involvement as observed by x-ray in pneumococcal lobar pneumonia is dense as compared with the lobular areas of light density seen in non-bacterial (virus) pneumonia. The leukocytosis is often very high in contradistinction to the comparatively slight leukocytosis of (virus) non-bacterial pneumonia.

The sulfa preparations, penicillin, and other forms of drug therapy have not been beneficial in treating uncomplicated non-bacterial (virus), atypical pneumonia. These cases are best treated symptomatically. Death seldom occurs from the uncomplicated disease. The sulfa drugs and penicillin are useful only for combating secondary bacterial invaders.

#### PATHOLOGICAL FINDINGS

Like others interested in primary atypical pneumonia, we have had only a limited opportunity for anatomical study of the disease, on account of the low mortality rate. In the late months of 1942, 3 cases which terminated fatally came under our observation. The clinical manifestations in these were so similar to those in numerous cases with recovery that a brief account of the pathological findings appears warranted.

The patients were young adults, aged 23, 30, and 36 years. Two were males. In none was there a history of recent serious illness. The main clinical features were moderate fever, dry and almost uncontrollable cough, and scanty sputum. The leukocyte count was not elevated. Repeated bacteriological examinations did not disclose the incitants of pneumonic disease. Dyspnea and cyanosis appeared in the last days of life. In each instance the duration of the disease was around three weeks.

Although it is quite probable that the anatomical changes found were more extensive and severe than those in non-fatal

cases, the restriction of the lesions to the bronchi and bronchioles, without the development of bronchopneumonia of any important extent, was truly remarkable. The findings in the three cases were so similar that they are most easily described in summary fashion.

The lungs were voluminous and of about twice normal weight. The pleurae were smooth and not involved. Although the lungs were firm, they contained no sizable areas of consolidation and were even emphysematous in portions. The main bronchi contained mucopurulent sputum. Gross sections showed small opaque areas, mainly of circular shape, about the large bronchial radicles. Palpable consolidation was confined to the central parts of the lungs. In the peripheral portions the cut surfaces presented a finely mottled appearance with reddish-gray spots 3 to 4 mm. in diameter, with lighter colored and air-containing areas between them. Small bronchial branches were recognizable in the darker areas and these contained fine droplets of thick, mucoid material. Interstitial hemorrhage was not a feature. Thrombi were found in medium-sized branches of the pulmonary arteries—in some 3 mm. or more in diameter. In smaller branches they were visible only after fixation and were much more evident in microscopic preparations. The thromboses were not accompanied by infarct formation. The areas supplied by the thrombosed vessels were pale red and slightly edematous.

Histologically, the lesions were most severe in the central portions of the lungs and especially about the larger bronchi. In some of the larger branches the walls were partially necrotic and the lumina contained epithelial debris and purulent exudate. Radicles of about equal size showed partial necrosis of the walls with detached and folded epithelium in the lumina but without purulent reaction. In the purulent exudate, small clumps of gram-positive cocci were readily demonstrable.

The lesions in the finer bronchial radicles were much simpler and less complicated by necrosis, reaction to cell debris, and by

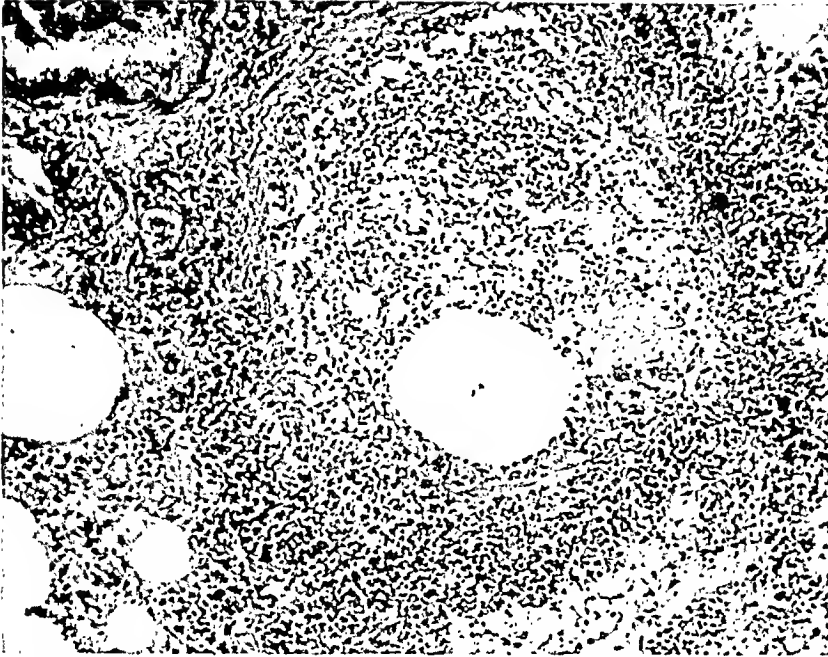


Fig. 3. Section through a small bronchial radicle. The mucosa is entirely destroyed. Remnants of the muscle coat remain. There is compact infiltration of the outer coats by mononuclear cells.

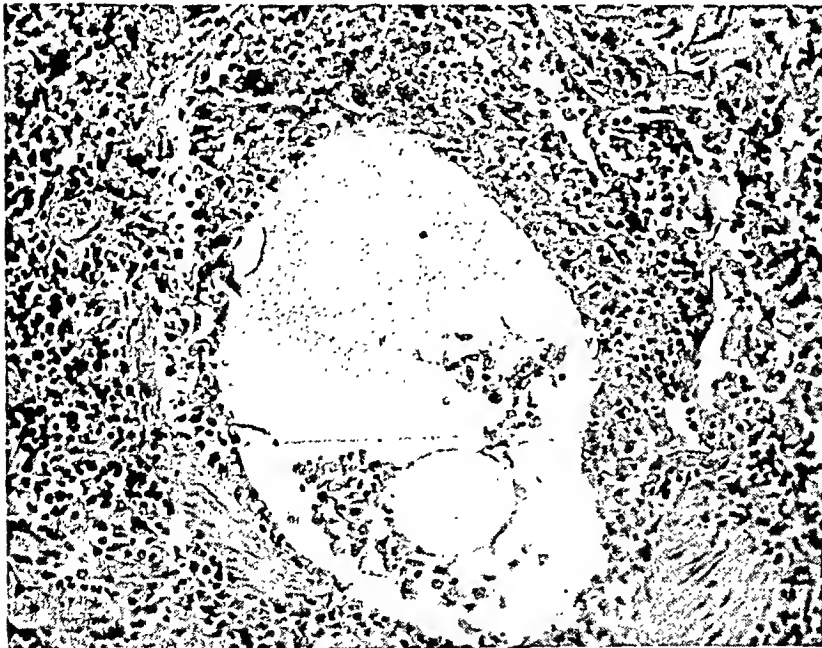


Fig. 4. Section through a bronchiole. The mucosa is completely destroyed. The lumen contains mucous fluid. Note the mononuclear character of the cells in the lumen.

secondary invasion by mouth organisms. In these the lumina were filled with mononuclear cells and seromucinous fluid, with or without detached bronchial epithelium. The walls were uniformly infiltrated with mononuclear cells, and purulent reaction was entirely wanting. The detachment of bronchial mucosa appeared to be due to displacement by mononuclear cell infiltration and seromucinous fluid. Other and closely located bronchial radicles were filled with shreds of bronchial epithelial cells, air droplets, and serous fluid.

The thromboses in the pulmonary artery radicles appeared to be important and it is believed that they may have bearing on some of the transitory shadows seen in roentgen films.

#### SUMMARY

1. In a series of 91 cases of atypical pneumonia of non-bacterial origin, the average age of the patient was 20.9 years. Males and females were affected in approximately equal numbers. All but 2 of the patients were white.

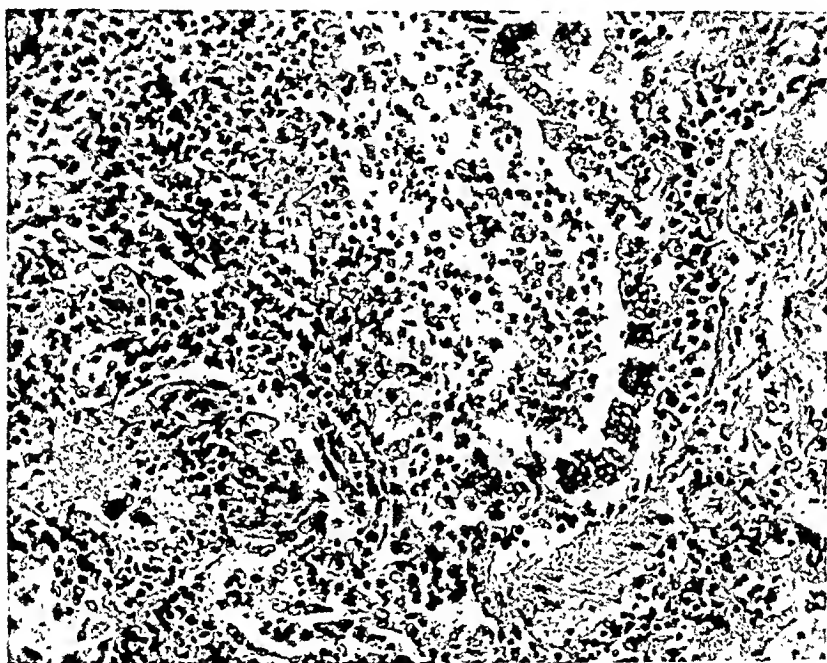


Fig. 5. Section through a small bronchiole. Detached epithelium and mononuclear cells fill the lumen.

The thrombi in the pulmonary artery radicles were compact, formed of fibrinoid material, platelets, and scanty leukocytes. They were loosely attached to the intima of the vessels and there was no inflammatory reaction in the vascular walls. Bacteria were not found in the thrombi.

The bronchiolar lesions were widely disseminated throughout all lobes. Microorganisms were not found in them and they had the characters of non-bacterial lesions. Intracellular inclusion bodies were not demonstrable. Significant changes were not found in other organs.

2. No definite cause of the disease was established, although it is thought to be caused by a virus of undetermined type, or possibly to be due to embolism of the small pulmonary arteries and veins, which would account for its peculiar distribution and transient nature, as suggested by the autopsy findings in 3 cases.

3. The diagnosis is established principally by exclusion of other known diseases, particularly bacterial pneumonias. The following were of value in arriving at a diagnosis: history, physical and laboratory findings, sputum and blood exam-

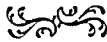
inations, including blood cultures, and x-ray studies. The clinical course, physical findings, and x-ray changes are in general milder than in bacterial pneumonias. The x-ray changes, though of a pattern, may be simulated by many other diseases and therefore are not characteristic.

4. No specific therapy is known. Symptomatic treatment is successful. Sulfa and other drug therapy is directed toward secondary invaders.

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# Anatomical X-Ray Studies of the Lung, Primarily for Tuberculosis<sup>1</sup>

EDWARD C. KOENIG, M.D.

Buffalo, N. Y.

THE IMPORTANCE of roentgenology in the diagnosis of pulmonary tuberculosis has been gradually and surely established. The clinical symptoms and the infectious nature of the disease had been recorded in the literature by such men as Hippocrates, Laennec, Villemin, and others before Koch's discovery of the tubercle bacillus. By use of the x-ray, it is possible for the pathologist to write a more complete protocol of the lung findings, and it is the pathologist who frequently establishes the primary and contributing causes of death.

Ghon employed x-rays in his anatomical examinations of lung specimens only in exceptional cases in which most careful anatomic search failed to reveal minute calcific tubercles. Opie has made an extensive use of the roentgenographic method in his anatomical studies of pulmonary tuberculosis. Dr. Kornel L. Terplan, Director of Pathology at the Buffalo General Hospital, asked the co-operation of the X-Ray Department in the anatomical study of lung specimens. The purpose of such examination is to locate more easily and accurately very small chalky and calcified lesions. Histologic examination of all lesions was found to be indispensable.

Over a period of ten years we have

examined by x-ray 800 lung specimens. Doctor Terplan has selected the cases shown in the accompanying plates and prepared the brief summary attached to each illustration.

The technic used in producing these roentgenograms was as follows: The specimen was placed on the x-ray table top, protected by black photographic paper. The film, in a cardboard holder, was placed in the drawer of the Potter-Bucky diaphragm. The target-film distance was 28 inches. Other factors were: 75 kv., 35 ma., exposure time 3 1/2 seconds. The factors were adjusted to the size of the specimen.

The above factors gave satisfactory roentgenograms of the lung specimens, as the accompanying plates demonstrate. The specimens were not inflated with air nor were any other procedures used.

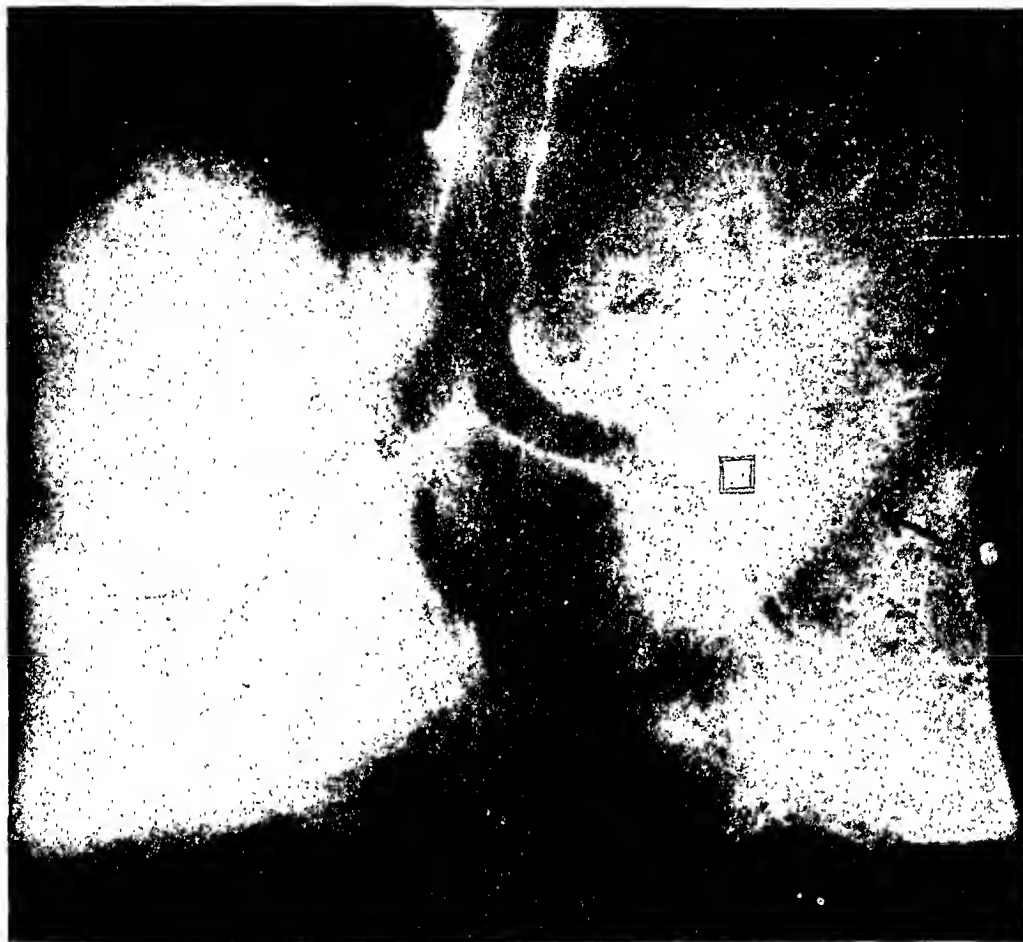
Before arriving at this method, many others were tried. The plain film and the Bucky diaphragm seem to be the principal factors.

The final pathological observations based on the large group of specimens studied will be published later by Doctor Terplan. The purpose of this paper is simply to present a method that produced satisfactory roentgenograms of lung specimens.

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

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## PLATE I



Specimen from a white adult. Cause of death: automobile injury with concussion of the brain. Diffuse aspiration pneumonia, especially of the right lung.

There is a primary tuberculous complex in a chalky calcified state, with a typical primary focus in the upper third of the left lower lobe. The minute calcified chalky tubercle in one regional bronchopulmonary lymph node was the only lymphogenous metastasis in this case. There was no further extension of the primary infection. Without the roentgenogram, this small complex change would probably have been missed.

## PLATE II

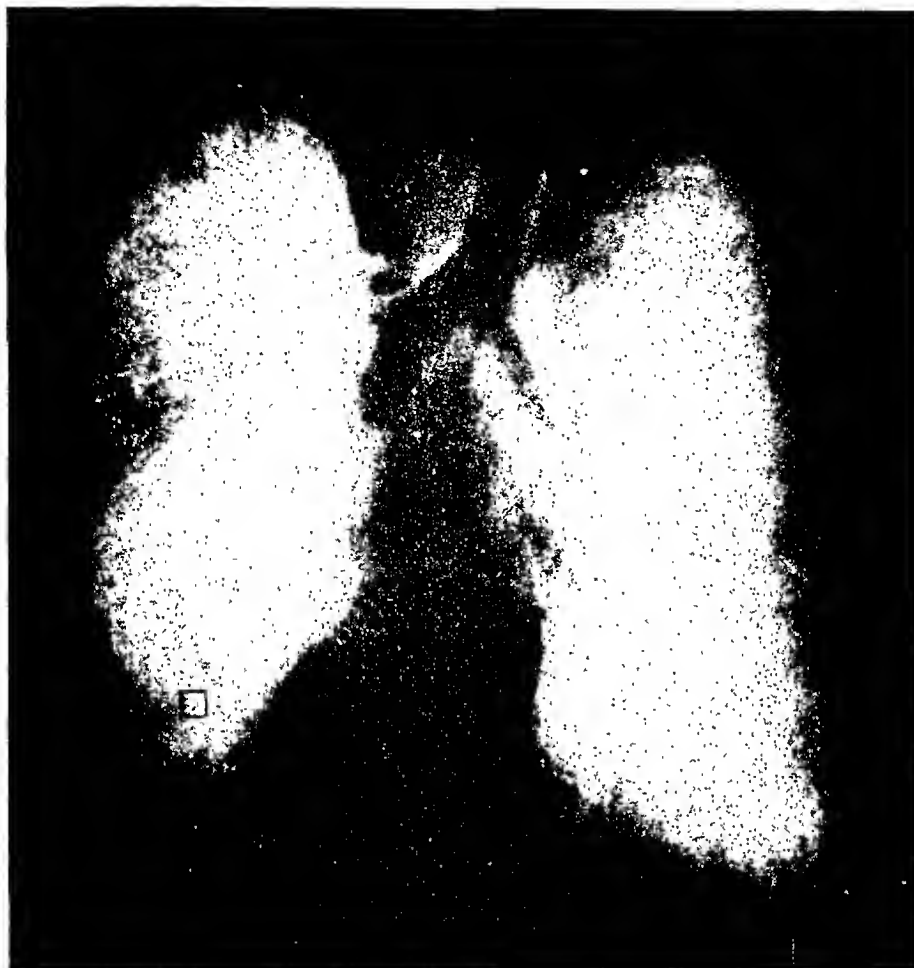


Specimen from white female, 22 years of age. Cause of death: chromaffinoma.

This roentgenogram, like that reproduced in Plate I, shows a calcified tuberculous complex of primary infection. In this case, however, the relationship between the primary focus and complex changes is reversed, as compared with the former case. The primary focus is most minute, calcified, in the mid-third of the left upper lobe near the interlobar fissure. The regional lymph-node changes are comparatively extensive and involve the bronchopulmonary and upper tracheobronchial group. (In this case the right lung was in part dissected before the roentgenogram was made.)



## PLATE III



Specimen from a 33-year-old white female. Cause of death: bacterial endocarditis.

In this case there was no anatomical trace of any tuberculous infection. The two minute calcified nodules, one in the subapical area of the right upper lobe, the other in the right lower lobe, proved to be typical phleboliths in their histologic structure.

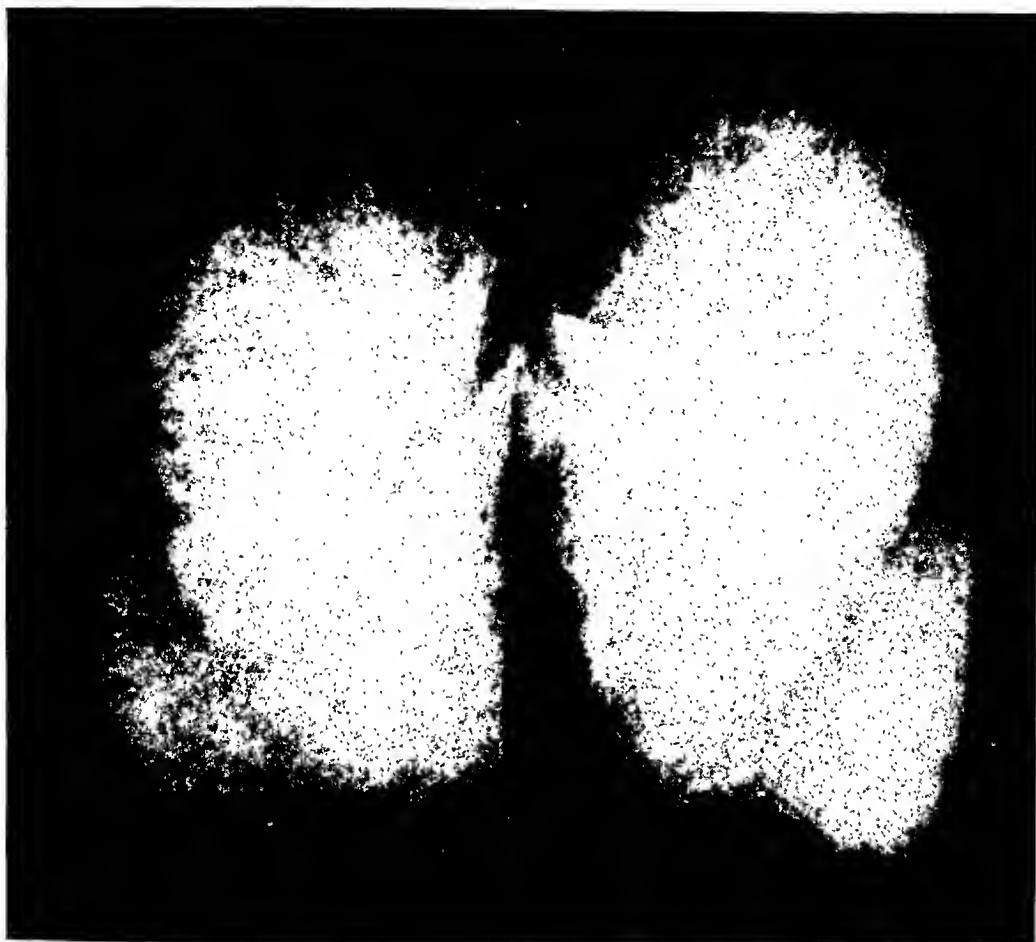
## PLATE IV



Specimen from a 73-year-old colored male. Cause of death: progressive pulmonary tuberculosis.

There are two firm, stony, ossified complexes of primary infection in the hilar area of the left lung and in the right lower lobe. The primary focus on each side is split up into multiple small fragments. In the lymph nodes in the left hilum, belonging to the left bronchopulmonary group, there is considerable anthracosilicosis combined with calcified tuberculosis. Most of the left upper lobe showed diffuse caseated pneumonia. The tuberculous process in the right lung was of more nodular peribronchial type. Tracheobronchial and paratracheal lymph nodes on both sides showed massive caseation.

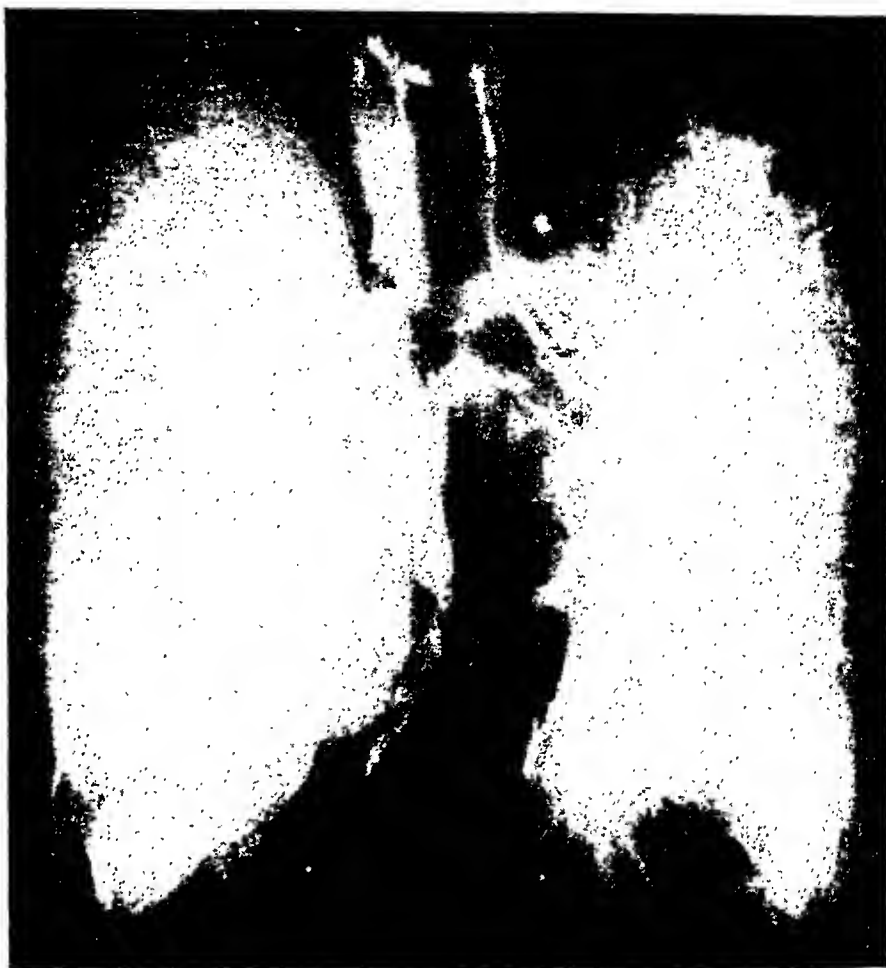
## PLATE V



Specimen from a 47-year-old colored female. Cause of death: miliary tuberculosis in association with a caseous tuberculous of the lumbar spine.

In this case there was no evidence of a primary complex formation. In the right apex fibrocaseated tubercles were found, with firm adhesions to the pleura. The small calcified nodule in the lateral part of the right lower lobe proved to be a phlebolith. The unusually dense miliary tuberculosis throughout both lungs is clearly demonstrated.

## PLATE VI



Specimen from a 60-year-old white male. Cause of death: Hodgkin's disease of liver, spleen, and retroperitoneal lymph nodes.

This roentgenogram shows an old calcified primary complex with the primary focus in the subapical area of the right upper lobe and with firm calcification of two lymph node groups, one bronchopulmonary node, and several upper tracheobronchial nodes on the right side. A small lymph node between the right upper and right middle lobes showed also a minute calcified tubercle.

The large globular shadow in the lower field of the right upper lobe was a huge caseated focus of reinfection. The regional bronchopulmonary lymph nodes, including the calcified tubercle in one bronchopulmonary node at the hilum, showed anatomically diffuse caseation. This is noticeable immediately to the right of the single calcified tubercle at the angle formed by the upper and lower main bronchus.

## PLATE VII



Application to the kidney and surrounding structures of x-ray technic used in lung studies. This unusual roentgenogram was obtained at the death of a 51-year-old white male, from coronary thrombosis. He had been treated for a kidney stone for some time preceding his death.

The right kidney was almost entirely transformed into a firm, calcified chalky structure, with its upper half completely replaced by a chalky stone. Both adrenal glands showed distinct calcific, fibrous, chalky tuberculosis. There was also localized calcific atherosclerosis of the abdominal aorta. Note the compensatory hypertrophy of the left kidney. The ureter was completely obliterated. (More detailed discussion of this unusual finding will be published later.)

This chronic tuberculosis of the right kidney was metastatic to an otherwise typical exogenous reinfection tuberculosis in chalky fibrous state in the left upper lobe. A nodule in the subapical area of the left lung was likewise an old calcified tubercle, apparently secondary to the primary lesion or the effect of an old superinfection.



# Factors Influencing Mortality in Head Injury<sup>1</sup>

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Chicago, Ill.

IT HAS LONG BEEN recognized that the most important factors in a given case of head trauma are the location and severity of the brain injury. A great deal of attention has consequently been paid to that phase of the problem, and, while much remains to be elucidated and there is a great deal of confusion in the literature in the usage of such terms as concussion and contusion, we do have much important clinical and experimental information on brain injury. As has been pointed out elsewhere (Voris, Verbrugghen and Kearns), however, an estimate of the degree and extent of the injury to the brain at the time the patient first comes under observation is often difficult if not impossible. A simple clinical classification that may be applied at this time has been suggested. This classification groups the patients as follows: (a) moribund; (b) gravely injured; (c) mildly injured; (d) complicated cases. Any cases in the first three groups, even in group a, may fall into the fourth group of complicated cases because of associated injuries, old age, or pre-existing disease or debilitation. Thus in actual experience it early becomes apparent that there are many other factors influencing mortality besides the primary ones of the location and severity of the brain injury.

Of these various factors, probably the most important is the age of the patient. During the four-year period, 1939-1942, inclusive, 2,714 cases of head injury were cared for on the author's neurosurgical service at the Cook County Hospital. There were 298 deaths in this group, a gross mortality rate of 11 per cent. Table I gives the distribution of these cases by decades with the mortality rate for each decade. This shows the great importance

TABLE I: AGE DISTRIBUTION OF 2,714 CASES OF HEAD INJURY

Decade	Total Cases	Dead	Mortality Rate
10-19	141	7	5.0%
20-29	332	16	4.8%
30-39	502	25	5.0%
40-49	548	45	8.2%
50-59	486	49	10.1%
60-69	281	39	13.9%
70-79	109	25	22.9%
80-89	15	3	20.0%
Unknown	300	89	29.7%
TOTAL	2,714	298	11.0%

of the age of the patient in determining his chances for recovery. The older patient with a head injury is, of course, subject to many complications that a younger person is less liable to suffer from. These include hypostatic pneumonia, cardiovascular-renal complications, and late cerebral vascular changes. Then, too, the elderly patient who is admitted to a charity hospital is often debilitated and ill-nourished. Still another factor seems to be of great importance, namely, the impairment of the circulation of the brain in many elderly persons, with consequent poorer reparative response to injury. Reference to Table I shows there was a considerable group (300 cases) of severely injured derelicts in whom the exact age was never ascertained. As might be anticipated, this group showed the highest mortality of all, almost three times that for the entire series.

Fracture of the skull has, especially in the past, received undue emphasis in cases of head injury. One writer (Mock) has gone so far as to use the presence or absence of fracture of the skull as a so-called "yardstick" for evaluation of the seriousness of head injury and has confined his statistical analyses to proved cases of skull fracture. Many men responsible for the immediate care of head injuries deem it their duty to obtain immediate roentgenograms of the skull, no matter what the

<sup>1</sup> From Loyola University Medical School and the Cook County Hospital, Chicago, Ill. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Dec. 1-2, 1943.

physical condition of the patient or his ability to co-operate. The records of the coroner's physician of Cook County for several series of necropsies on patients dying of head injury show that in 30 to 40 per cent of such cases no fracture of the skull is demonstrable at the postmortem table.

Unfortunately the coroner's physician did not find it possible to perform necropsies in all of the 298 deaths in the present series of head injuries from the Cook County Hospital. Complete examination of the intracranial cavity and its contents was carried out in 120 cases (Table II). In 52 of these (43.3 per cent)

TABLE II: SKULL FRACTURE IN 2,714 CASES OF HEAD INJURY

	Total Cases	Deaths	Mortality Rate
Fracture	635	105	16.5%
No fracture	2,079	193	9.3%
<b>TOTAL</b>	<b>2,714</b>	<b>298</b>	<b>11.0%</b>
Total necropsies.....	120 (40.3% of deaths)		
Skull fracture.....	68 (56.7%)		
No skull fracture.....	52 (43.3%)		

no skull fracture was found. This single fact effectively shows the lack of importance of skull fracture in prognosis in cases of head injury. In the entire series of 2,714 cases there were 635 patients in whom a skull fracture was demonstrated by roentgenograms, at the operating table, or by postmortem examination, or who presented presumptive clinical evidence of a basal skull fracture. By presumptive clinical evidence of a basal skull fracture we mean discoloration of one or both orbits developing twelve hours or more after the injury, discoloration over one or both mastoids (Battle's sign), bleeding from the nose (without evidence of nasal injury), or drainage of cerebrospinal fluid from the nose or ears. In this group of 635 cases of proved or presumptive skull fracture there were 105 deaths, a mortality rate of 16.5 per cent as compared to the mortality rate of 11 per cent for the entire group. This is surely not a significant difference, especially when it is contrasted with the

TABLE III: CEREBROSPINAL FLUID FINDINGS IN 797 CASES (29.4 PER CENT OF TOTAL)

	Total Cases	Dead	Mortality Rate
Total punctures	797	141	17.7%
Blood-tinged fluid	154	39	25.3%
Gross blood	157	59	37.6%
Xanthochromic fluid	130	19	14.6%
Clear fluid	356	24	6.7%
Increased pressure	363	88	21.5%
Normal or low pressure	434	53	12.2%

43.3 per cent absence of skull fracture in the 120 cases that were examined post-mortem.

Our practice at the Cook County Hospital is to postpone roentgenography of the skull until the patient is conscious, co-operative, and out of danger. There are, of course, certain exceptions to this rule. These include compound depressed fractures, penetrating wounds of the cranial cavity, suspected middle meningeal hemorrhage, and fractures involving the nasal accessory sinuses. In compound depressed fractures and the special subvariety of these, penetrating wounds of the cranial cavity, roentgenograms of the skull should be made preoperatively to determine the nature and extent of the bony injury and the location of retained radiopaque foreign bodies. When middle meningeal hemorrhage is suspected, the presence of a fracture line crossing the vascular markings of the middle meningeal vessels is not only of diagnostic but also of localizing value, as it indicates the probable point of rupture of the artery. If fracture involving the nasal accessory sinuses is suspected, early roentgenograms are of importance in determining whether traumatic cerebrocele exists. With the above exceptions, the presence or absence of skull fracture is not of sufficient clinical importance to warrant attempts to obtain roentgenograms of the skull until the favorable circumstances referred to above are present.

Of much more prognostic importance than the presence or absence of skull fracture is the appearance of the spinal fluid. Diagnostic spinal punctures were done in 797 cases, or 29.4 per cent of our series (Table III). This group represented



more serious injuries than the series as a whole, for there were 141 deaths, or a mortality of 17.7 per cent, as contrasted to 11 per cent for the entire series. However, in the 356 cases in which clear fluid was found there were only 24 deaths (6.7 per cent), a mortality rate considerably less than that for the entire series. As the table shows, with the presence of blood in the spinal fluid the mortality rate is greatly increased, especially if the fluid is grossly bloody. In the latter case, either severe cerebral contusion or laceration may be assumed to be present.

Increased pressure of the spinal fluid as measured with a manometer on lumbar puncture is in itself a factor associated with increased mortality, as Table III shows, the mortality in such cases being 21.5 per cent as contrasted to 12.2 per cent in the cases showing normal or low pressure. Increased pressure means spinal manometric readings in excess of 140 mm. of water with the patient in the horizontal position and relaxed. In this connection it must be pointed out that a normal or low manometric pressure as measured from the lumbar subarachnoid space does not mean necessarily that intracranial pressure is normal. Partial block due to cerebral edema with or without foraminal herniation at the foramen magnum or the incisura of the tentorium may interfere with the transmission of cerebrospinal fluid pressure from the intracranial cavity to the lumbar subarachnoid space. In certain cases, because of swelling of the brain, the cerebrospinal fluid is squeezed out of the ventricles and cranial subarachnoid spaces. Neurologic surgeons sometimes have the experience of finding such a situation in deep-seated, infiltrating supratentorial tumors. In such cases, if the ventricles are tapped, only a few drops of fluid may escape under decreased pressure. Yet the brain may be under greatly increased tension and bulge markedly when the dura is opened. In its way, it is just as unfortunate to use the lumbar manometric pressure as a "yardstick" of intracranial pressure in head injuries as it is to use the presence

or absence of skull fracture as a "yardstick" of the severity of the brain injury.

In 1,206 cases in the series there were associated injuries to other parts of the body. Table IV shows the distribution of

TABLE IV: ASSOCIATED INJURIES IN 1,206 CASES (44.4 PER CENT OF TOTAL)

	Cases	Deaths	Mortality Rate
Face	795	69	8.7%
Extremities	456	54	11.8%
Chest	156	32	20.5%
Abdomen and pelvis	53	5	9.4%
Neck	46	5	10.9%
Spine	28	5	17.9%
Spinal cord	7	3	42.9%
Peripheral nerves	2	0	0
Miscellaneous	17	3	17.6%

these injuries (which in some cases were multiple) and the mortality for each group. Injuries to the face and extremities were by far the most frequent. The mortality rate, however, was not seriously influenced by the presence of these injuries. On the other hand, injuries to the chest, spine, or spinal cord, particularly to the cord, materially increased the mortality rate. Injuries to the chest add to the risk, especially in older people. It is our practice to get elderly patients out of bed as soon as their condition permits, regardless of subjective symptoms or of mental confusion. Another valuable procedure in the patient with chest injury is paravertebral novocaine or alcohol injection of the intercostal nerves supplying the injured area. This relieves the pain and anxiety and permits resumption of more normal respiratory excursions. It not only makes the suffering patient more comfortable but contributes to his chances of survival.

Pre-existing chronic disease was present in 383 cases, as shown in Table V. Cardiovascular and renal disease contribute the most to increased mortality. The mortality rate when tuberculosis was present was also higher than for the series as a whole, but the group of cases was very small, numbering only five.

Associated disease developing acutely is usually either meningitis or pulmonary infection. The frequency of these con-

TABLE V: ASSOCIATED CHRONIC DISEASE IN 383 CASES (14.1 PER CENT OF TOTAL)

	Cases	Deaths	Mortality Rate
Alcoholism	234	19	8.1%
Epilepsy	30	3	10.0%
Cardiovascular disease	65	18	27.6%
Nephritis	5	3	60.0%
Diabetes	18	0	0
Syphilis	26	2	7.7%
Tuberculosis	5	1	20.0%
TOTAL	383	46	12.0%

ditions in the 120 fatal cases that were examined postmortem is shown in Table VI. Pulmonary complications were by far the most frequent, occurring in 18.3 per cent of this group. Meningitis was present in 7 cases, or 5.8 per cent of the group. This corresponds well with other published figures, which give meningitis as the cause of death in from 3 to 8 per cent of fatal head injuries. In our entire series there

TABLE VI: ASSOCIATED ACUTE DISEASE IN 120 NECROPSIES

Meningitis.....	7
Pneumonia.....	18
Lung abscess.....	4
Cardiovascular-renal disease.....	9

were 20 cases of meningitis with 12 deaths, a mortality of 60 per cent. This falls far short of the ideal, but, on the other hand, the 40 per cent of recoveries represents a material gain over the death rate before the advent of sulfonamide therapy.

General prophylactic measures are of great importance in patients with scalp lacerations, compound fractures, bleeding from the ears or nose, and rhinorrhea or otorrhea. Thorough and meticulous débridement of all wounds involving the scalp and bone should be carried out, with excision of contaminated and devitalized tissue. If the dura is penetrated, the cerebral wound should be "débrided" by appropriate neurosurgical methods (using suction and irrigation). Foreign bodies should be removed if that does not entail damage to uninjured cerebral structures. These major neurosurgical procedures must be postponed, however, until the condition of the patient permits and proper operating conditions can be attained. The

sooner they are carried out after the injury the better, but for the reasons stated it may be necessary to delay them for as long as seventy-two to ninety-six hours. The pre-operative and postoperative administration of sulfonamides is of great value but must never be substituted for proper surgical treatment.

Patients with bleeding or drainage of cerebrospinal fluid from the ear or nose should be kept flat in bed. There must be no interference with the drainage, and irrigations are strictly contraindicated. Sulfonamides, preferably sulfadiazine, should be administered prophylactically during the period of drainage and for at least seventy-two hours thereafter. Drainage of cerebrospinal fluid from the ear almost always stops spontaneously within forty-eight hours; drainage from the nose usually does so. If it does not cease within a few days, plastic closure of the dural defect should be carried out through a transfrontal craniotomy, the condition of the patient permitting. This should be undertaken only by a competent neurosurgeon under proper operating conditions.

Fractures involving the frontal sinus with external compounding of the wound call for operation, like other cases of compound fracture. Where external compounding of the wound has not taken place, the patient must be watched carefully and roentgenograms be taken repeatedly. If pneumocephalus develops, immediate operation is indicated, with repair of the dural defect through a transfrontal craniotomy, as in cases of persistent rhinorrhea.

When a patient who has suffered a head injury shows signs of meningitis, spinal puncture should be done at once. If there is a pleocytosis, sulfonamides should be used in massive doses. Daily blood counts and sulfadiazine levels should be determined. Lumbar puncture should be performed at intervals of one to three days until the cell count is normal and cultures are sterile. Therapy should be continued several days after the patient has clinically recovered and the cerebrospinal findings are normal. Penicillin offers great

promise in the treatment of post-traumatic meningitis. Perhaps we may yet equal or improve upon the goal of a 25 per cent mortality set by Grant.

#### SUMMARY

1. The location and severity of the brain injury are the most important factors influencing mortality in injuries of the head.

2. Next in importance is the age of the patient.

3. The presence or absence of skull fracture is not of importance except in compound fractures, depressed fractures, fractures involving the middle ear or nasal accessory sinuses, and fractures causing a tear of the middle meningeal artery or one of its branches.

4. The presence and amount of blood in the cerebrospinal fluid are an important prognostic sign. When lumbar spinal pressure is increased, the mortality rate is higher, but lumbar spinal manometric readings do not always give a dependable indication of intracranial pressure.

5. Associated injuries, especially of

the chest, spine, or spinal cord, significantly increase the danger to the patient's life.

6. Associated disease does likewise, particularly cardiovascular-renal disease and acute pulmonary complications.

7. Meningitis is relatively rare but has a high mortality and must be treated promptly and energetically if the patient is to survive.

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# Revascularization of the Carpal Bones<sup>1</sup>

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with

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THE INCREASE in interest in fractures of the carpal navicular and lunate bones is evidenced by the large number of articles that have in recent years appeared in literature. Unsatisfactory results have always stimulated the profession to try new methods. In this instance there is an added stimulus, namely, industrial and military.

The history of the treatment of carpal fractures parallels that of fractures of the neck of the femur. The causes of failure are similar, namely, interference with the blood supply, inadequate fixation, and intra-articular fracture, the exception being, of course, fracture of the tuberosity of the navicular. The treatment is similar in that it consists of long immobilization in plaster, drilling, pegging, and finally, in many instances, excision.

For the past eight years or more we have studied many carpal injuries, with special attention to the circulation. As is well known, the circulation to the carpal bones is through their ligamentous attachments (Fig. 1). The blood supply of the carpal navicular is through the foramina at its ligamentous attachments. The two main areas are the tubercle and the waist. The proximal pole does not have a good blood supply. Nutrition of the lunate is derived from the dorsal and volar surfaces of the wrist through the foramina. It is thus readily understandable why, in dislocations where the dorsal surface is interfered with, the patient still has circulation in the volar surface. In some cases where the lunate has been dislocated for weeks or months there may be only a minor difference in density; this indicates that some circulation is present, and the dislocation should be

reduced. The prognosis as to the ultimate outcome depends entirely on the degree of dislocation and the interference with the circulation. Where the blood supply is completely cut off, aseptic necrosis or Kienböck's disease usually develops (Fig. 2).

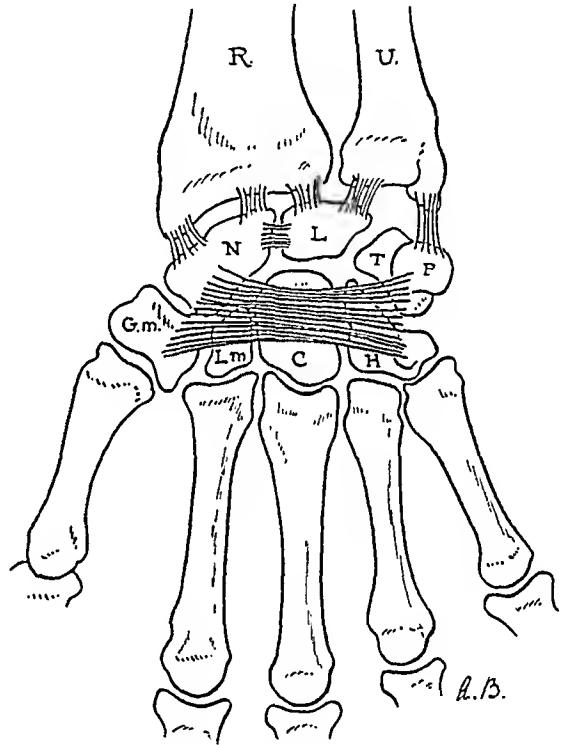


Fig. 1. Ligamentous attachments of the carpal bones.

Fractures of the navicular are divided, on the basis of their circulation, into three groups. (1) Fractures of the tubercle show a high percentage of bony union because of the adequate blood supply. (2) Fractures of the waist, or circular portion, usually heal if properly immobilized over a long enough period. Frequently incomplete fractures in this area are missed unless enough roentgenograms are taken at the time of injury. Even then it is many times difficult to demonstrate a fracture, and only

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

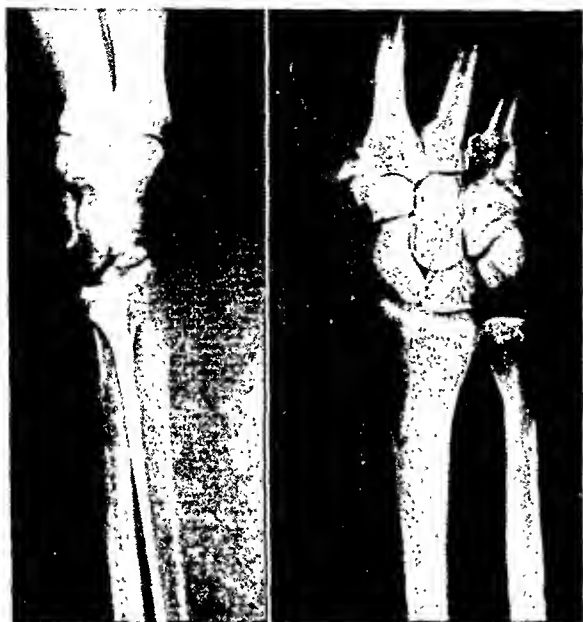


Fig. 2. Dislocation of lunate, of months' duration. There is no difference in density because the volar circulation is still intact.

later will re-examination, because of the continuation of clinical symptoms, reveal absorption at the fracture line and lead to the correct diagnosis. Healed fractures may be manifested in the form of residual central necrosis. (3) Fractures of the proximal pole, because of inadequate circulation, often fail to unite. Bony changes ensue and it is necessary to excise the fragment. In the presence of small fragments of the proximal pole many authors advise early removal, before arthritic changes occur. Better functional results are usually thus obtained, while with long periods of immobilization these cases usually fail to respond to treatment.

Accompanying dislocation and associated soft-tissue lesions usually increase the incidence of vascular disturbance. In such cases manipulation should be done with care because of the danger of further circulatory interference. If a reduction cannot be obtained, it is better to perform an open operation and carefully reduce the fracture dislocation rather than to continue with vigorous manipulation. The ligamentous structures should be accurately repaired in order to aid in the restoration of the blood supply. If properly

reduced, the greater percentage of fractures and dislocations will heal, but frequently the intercarpal ligamentous attachments fail to reform with normal firmness and a separation or partial rotation of the involved bones results. This may lead to arthritic changes followed by disability.

Various stages of revascularization can be observed following either open or closed reduction of these fracture dislocations. This includes fracture dislocations of the navicular and dislocations of the lunate carpal bone. An example is dislocation of the lunate carrying with it the proximal fragment of the fractured navicular. This fragment is firmly attached to the dislocated lunate by the intercarpal ligament and, after reduction either by the open or closed method, usually undergoes circulatory changes. These changes are reflected by the difference in density in comparison with the other carpal bones (Fig. 3). This is the most important time in the treatment of this serious injury. Doctor Cubbins has called this fragment "dormant" bone, because it is in the stage awaiting necrosis or revascularization. The invasion of the necrotic fragment is indicated on x-ray examination by loss of bone density and formation of "bone cavities," first seen adjacent to the fracture site. This is the earliest clinical evidence of bone repair. Phemister has described this beginning revascularization and transformation as "creeping substitution."

The slight degree of arthritic change occurring in both the wrist and the carpal bones is astonishing considering the prolonged interruption of blood supply and lack of nutrition to the injured bones. One would expect degeneration of the hyaline cartilage overlying the fracture or dislocation to be rather extensive, but in most cases this complication has not been apparent except as evidenced by a slight indentation at the fracture site. This indentation usually occurs directly opposite the radial navicular articulation, especially if the fracture is not accurately approximated. Arthritic changes will invariably occur in this area.

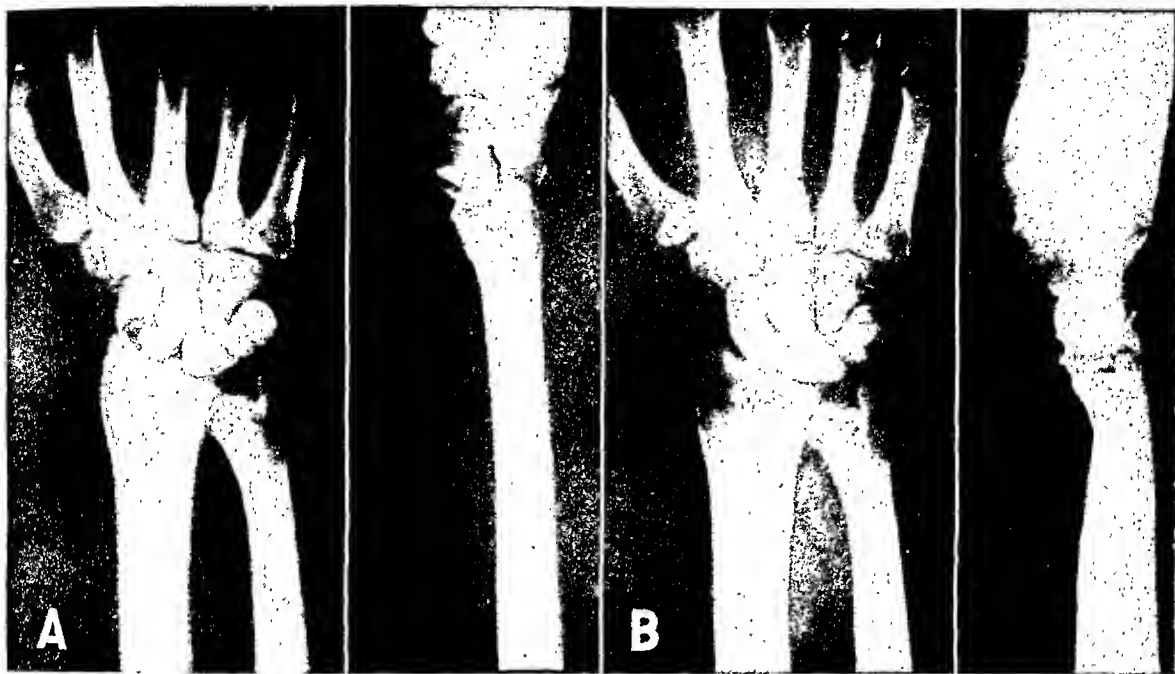


Fig. 3. A. Fracture dislocation of navicular with dislocation of lunate, six weeks old. B. Same case after open reduction (three months old). Note vascular changes evidenced by difference in density.

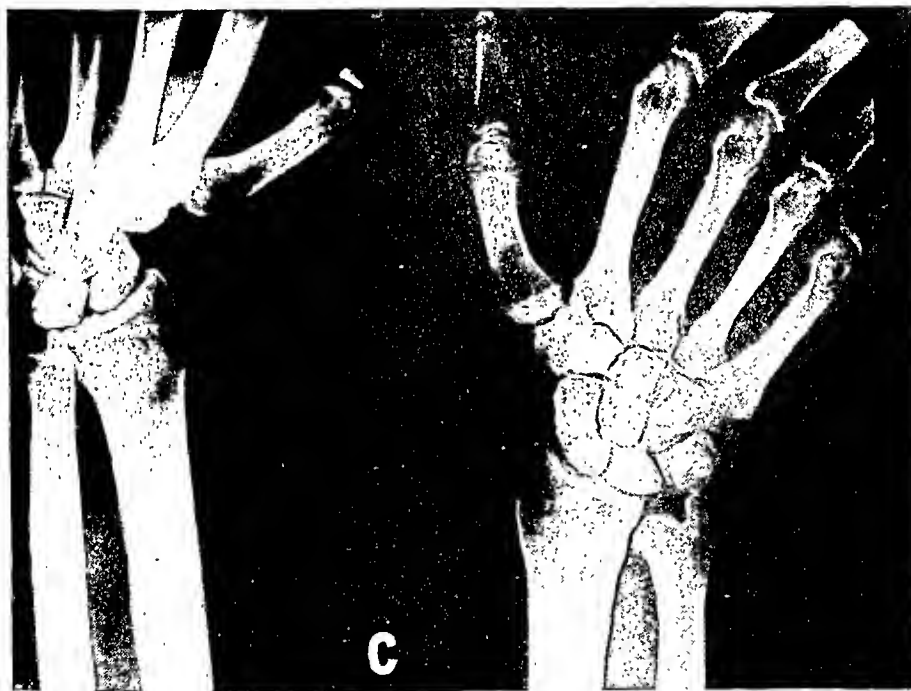


Fig. 3. C. End-result of case shown in Fig. 3, A and B, after two years.

Complete revascularization of the fracture or/and dislocation takes from nine to twelve months and sometimes longer. We have observed cases requiring as long

as two years for completion of the process. In some of the cases treated, revascularization required nearly as long in the child as in the adult. In one instance where only a

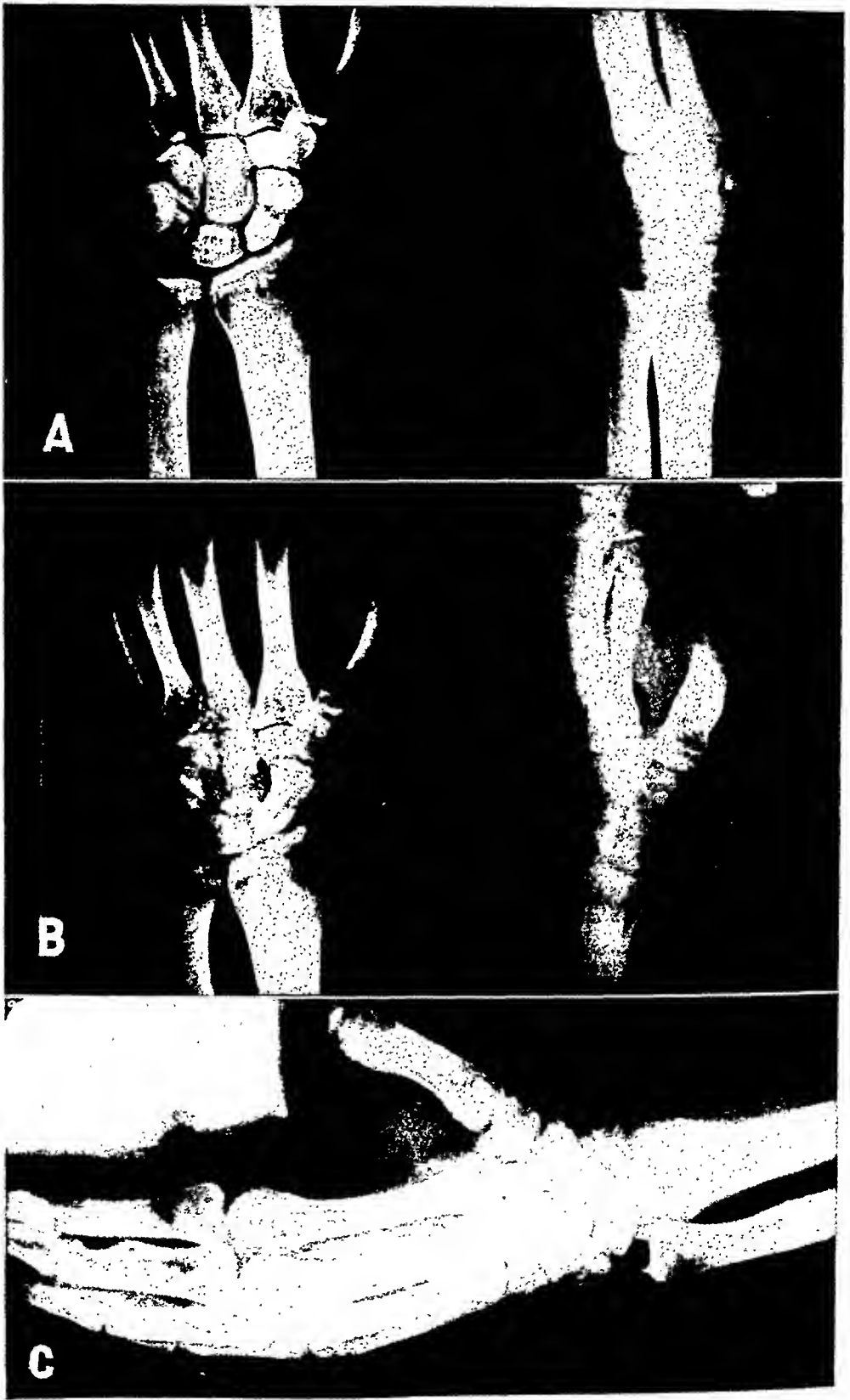


Fig. 4. A. Ununited fracture of navicular, eighteen months old. B. Postoperative view, five months old. C. End result. Note rough articular area on navicular at old fracture site.



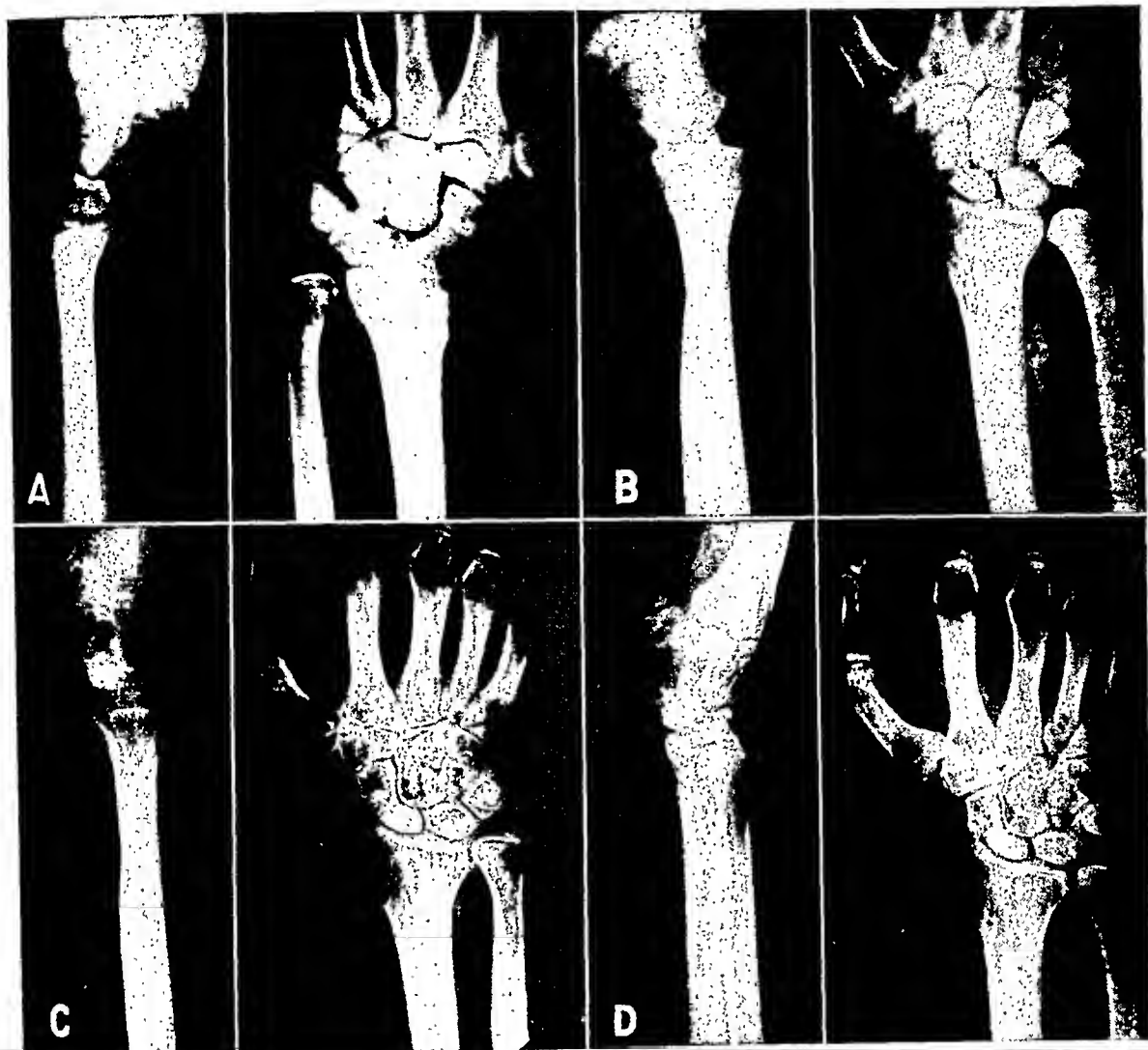


Fig. 5. A. Fracture dislocation of carpal navicular. B. Open reduction with immobilization by bone peg from radius. Note that the reduction is not accurate and vascular changes are present. C. Beginning bony union six months later. D. End result, three years later. Note arthritic changes at radius, possibly due to inaccurate reduction.

fracture of the navicular occurred in a fifteen-year-old boy, over nine months' immobilization was necessary before complete union occurred. This was due to the severe soft-tissue damage accompanying the fracture, interfering with the circulation to the carpal bones.

Fractures of the navicular may be seen following epiphyseal separations in children and, while this is not common, it should not be overlooked. Following reduction of the epiphyseal separation the neutral position is preferable to ulnar deviation because of the danger of separating the proximal and distal fragments of the navicular car-

pal bone. Longer periods of immobilization are required because of the fractured navicular than would ordinarily be necessary for the epiphyseal separation.

Recently there has been an increase in the number of comminuted fractures of the radius and ulna complicated by carpal injuries. This serious condition usually requires a long period of immobilization. It produces vascular interference, resulting in functional disability and post-traumatic arthritis and/or osteoporosis of the navicular or Preiser's disease, and, if it involves the lunate, Kienböck's disease. It is necessary in these cases to reduce the

comminuted fracture and the accompanying carpal lesion and immobilize in the neutral position.

In cases of non-union of the navicular with clinical symptoms, where no cystic changes have occurred and where the arthritic changes are minimal, it has been our custom to freshen the fracture site and to secure it by a bone peg in order to obtain adequate reduction and immobilization (Fig. 4).

Following the pegging we frequently see changes of density caused by circulatory disturbances. These changes usually disappear with healing of the ligamentous structures followed by revascularization, though many months are required before the process is completed, resulting in a useful, painless, and functional wrist. Patients so treated should be able to resume their former occupations, and many have been able to carry on during the period of immobilization.

With fractures of the navicular accompanied by a wide dislocation or separation of the fragment, either proximal or distal, the question arises whether these fragments should be excised or replaced. This, I believe, is an individual problem depending on the amount and extent of soft-tissue damage and the site of the fracture (Fig. 5). An economic question also enters—would the patient be better off to have the fragment removed, accepting the disability and an early return to employment, or should the fragment be replaced followed by a long period of immobilization awaiting subsequent circulatory improvement.

In painful bipartite naviculars, success has been obtained by bone pegging, followed by immobilization. These carpal bones do not display the same amount of vascular change that is seen following fractures, as their circulation is usually not disturbed by severe trauma, and bony union occurs in a shorter period of time.

In conclusion, I would like to stress the following points:

1. Early rigid immobilization of fractures of the navicular should result in union if the circulation is within normal limits. If the proximal pole does not tend to unite, it should be removed early, before arthritic changes develop in the wrist joint.

2. Bone pegging or drilling of the navicular with cystic changes should be discouraged, as these cysts, even after packing with cancellous bone, usually do not heal, and arthritic changes occur.

3. Complete dislocation with a minimum amount of trauma requires early reduction and immobilization. In those cases which cannot be reduced by manipulation, operation should be performed and the ligamentous structures repaired.

4. In comminuted fractures of the wrist complicated by carpal injuries, the fractured radius and ulna should be reduced and the carpal bones reduced and held or immobilized in the neutral position. A guarded prognosis should be given because of the circulatory changes involving the carpal bones.

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# Close-Range Technic in Diagnostic Roentgenology<sup>1</sup>

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THE FUNDAMENTAL problem in roentgenography, according to the clear formulation of Weyl, Warren, and O'Neill is the selection of technical procedures which will produce roentgenograms having minimum observable unsharpness and predetermined average densities and contrasts. The solution of the problem in each case is dependent upon the exposure factors, such as the correct voltage, exposure time, and focal-film distance, and a combination of auxiliary devices, as cones and Potter-Bucky diaphragm (1). We are concerned, in the present paper, with but one of these factors, the focal-film distance.

In order to obtain a point source of x-rays and reduce the unsharpness of the image due to the size of the focal spot, it is commonly considered necessary to place the tube at a distance of 30 to 36 inches from the film. As the object-film distance increases, the focus-film distance must also be increased to insure the maximum definition. At an object-film distance of 2 inches and a focal-film distance of 2 feet, the distortion measures 9.05 per cent. At the same object-film distance, but a focal-film distance of 6 feet, the distortion is only 2.85 per cent. Decreasing the film distance increases and enlarges the shadow of the object which is not in direct contact with the surface of the film, increases the peripheral zone of the penumbral shadow, and causes distortion and lack of detail. The customary practice, therefore, is to take films from the greatest practical distance. A chest film is taken usually at 4 feet. For measuring the exact size of the heart, a film taken at 6 feet is regarded as necessary, and a similar long-distance technic is described by many roentgenologists for the spine and the skull.

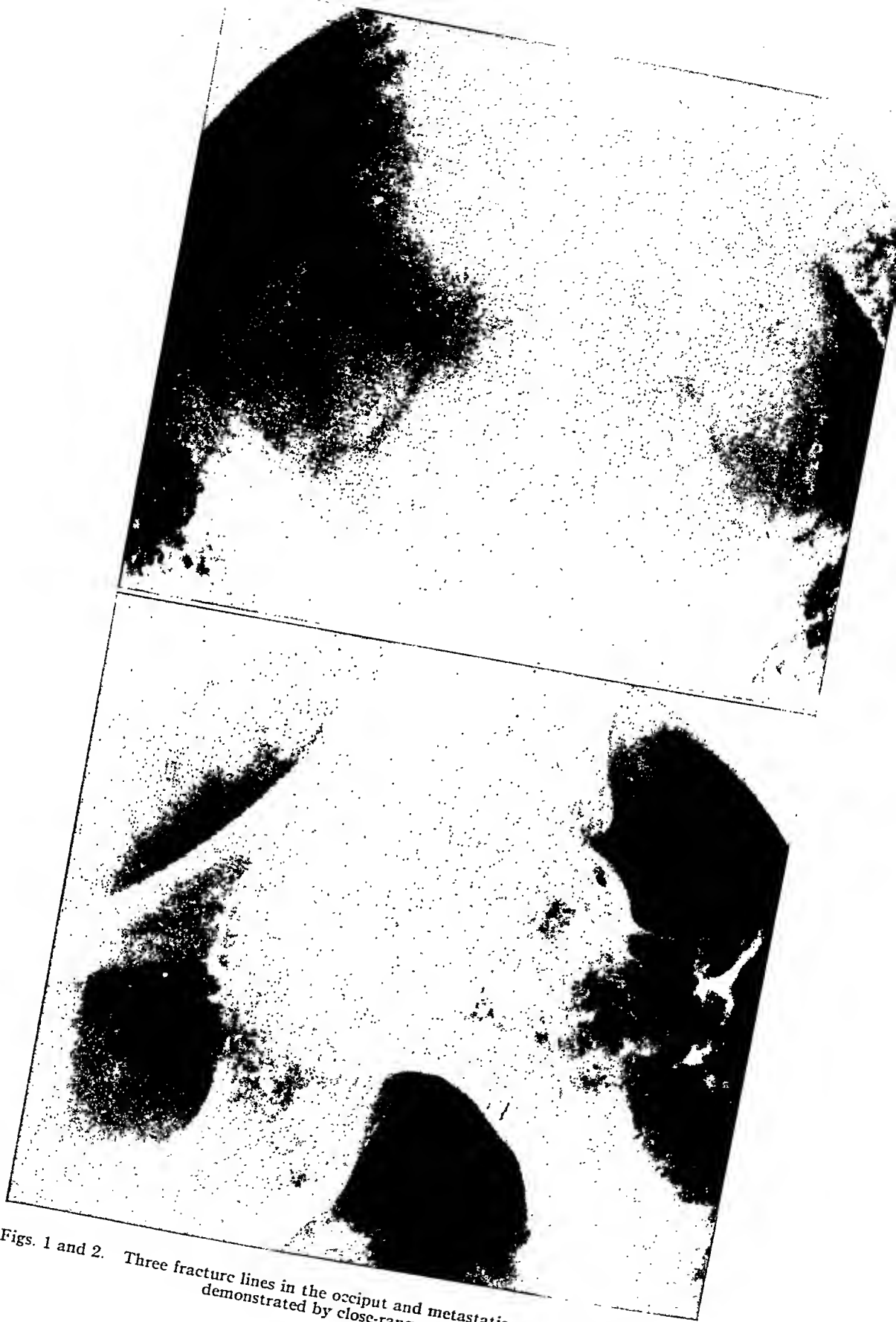
In contrast to such well established

rules, we find the occasional empirical use of what we may call "close-range technic." Even before the advent of the high-tension protected x-ray tube, we see one writer (2) empirically using a close-range technic for demonstration of the temporomandibular joint, and there are probably other instances where such technics may have been used. The *Cumulative Index* of the American Medical Association for the last few years makes no mention, however, of such technic, and it seems never to have been generally accepted.

The principal use of the close-range technic is for the demonstration of bone lesions wherever a fine analysis of a localized structure is required and where such a lesion is not too distant from the surface. The procedure consists in placing the tube either directly in contact with the part to be examined or, as we prefer in practice, with the interposition of a very short cone. We find a distance of 10 to 15 inches between the focal spot and the surface of the body the most suitable and use the shortest and narrowest cone available, just sufficiently wide to permit visualization of the line or structure in question. The exposure is reduced, 1 or 2 kilovolts less than at the conventional distance, with the same screens. The exposure time is diminished according to the inverse square law. It might be expected that such a technic would result in a loss of detail, distortion, and loss of contrast. Actually the part which is exactly traversed by the central ray is exceedingly clear, especially in bone work, and we believe that the trabeculation of the bone, acting like a Potter-Bucky grid, contributes to the sharpness of the image.

Toward the periphery, if the field is large, the unsharpness and the distortion increase. Therefore, exact centralization over the suspected area and a small cone

<sup>1</sup> Accepted for publication in April 1944.



Figs. 1 and 2. Three fracture lines in the occiput and metastatic carcinoma of the femur demonstrated by close-range technic.

are necessary. It is important that the object to be examined should be as near as possible to the film to avoid further enlargement and distortion. It is probably for that reason that the method proves especially valuable in the visualization of the temporomandibular joint, in fractures of the convexity of the skull, and in the demonstration of the sternum.



Fig. 3. Osteochondritis dissecans. Two small osteochondritic bodies are seen in their bed in the medial condyle. The sclerotic envelope and the sequestra are clearly visible in close-range films.

The enlargement of a circumscribed object is not objectionable. To see a pathological lesion in the ribs or in the skull, such as a tuberculous focus or myeloma, *enlarged* is quite frequently a distinct help in diagnosis. The close-range film should be taken after localization of the lesion on a scout film, to show the finer structures, sequestrations, and breaking down of cell walls. The technic further frequently permits the use of special high-definition and even non-screen films without undue prolongation of the exposure factors. Using a rotating anode tube or a fine focus, we have often obtained exceedingly sharp pictures over a circumscribed area, affording a more definite answer to a puzzling roentgenologic question. Such problems as the differentiation between vascular channels and a fissure fracture of the skull,



Fig. 4. Kidney carcinoma. Pressure upon the calices was visible on a conventional film, but tumor invasion of the kidney pelvis was clear only in a close-range film.

the search for osteomyelitic sequestra, the demonstration of loose bodies in the knee joint and their site of origin and of changes in the mandibular and clavicular joints are a few of many where the technic has proved valuable. Even in mastoiditis close range technic in addition to the conventional method has certain advantages, giving an enlarged and clear view of the state of the cell walls and the architecture of the cell system, which is more important than a knowledge of the correct size and shape of these cells.

It appeared doubtful whether the close-range technic could be used for examination of the gallbladder and kidney for the presence of stones, but we have found that this technic frequently gives a clearer view of the gallstones; that it may bring out more gallstone shadows than were first seen on the conventional film; and that the kidney calices and small stones in that area are more clearly seen and defined than on the primary survey film.

We were hesitant to use the close-range technic for identification of lung densities. Here, distances of 1.25 to 2 meters, are considered necessary to minimize shadow enlargement and avoid haziness. We first



Fig. 5. Gallstones as demonstrated by close-range technic. The centered close-range film brings out the details of stone structure, showing the dense center, translucent area, and faceted surface.

tried the method in the identification of fine apical shadows and found it valuable in the detection and analysis of such minor tuberculous densities and adhesions. We then proceeded to examine small areas of hilum and lung in the hope that it might be possible to attribute demonstrable lesions more definitely to the three systems of the lung (bronchus, vessels, and lymphatics), but our work in that line is still too limited for presentation at this time. We feel, however, that too much emphasis is given, in roentgenologic analysis and in reproductions, to the full picture of the lung, and not enough to the minute detail which is frequently more instructive than the life-size film. As in gastric roentgenography, spot films taken at close range over a suspected area are desirable.

#### SUMMARY

A close-range technic is advocated as a supplement to the conventional film for the examination of suspected lesions, such as sequestra, fractures of the convexity of the skull, osteochondritis dissecans, meningioma, inflammation of the temporomandibular joint, and other conditions where a finer analysis of a circumscribed area of bone destruction is required.



Fig. 6. Osteomyelitis. Sequestration, involucrum, and cloaca are clearly visible in this close-range film.

While the peripheral zone is indistinct and distorted, the combination of a fine focus, small cone, and high-definition screens gives an enlarged but distinct picture of the central area. A grid effect of bone trabeculation is believed to diminish the scattered radiation.

The principle of close-range technic has a wide field of application. It is not confined to the temporomandibular joint or even to the skeletal system but can be used to good advantage, also, in the detection of gallstones, kidney stones, and renal abnormalities, as well as in the analysis of various lung densities.

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## CASE REPORT

### Calcification of Infarctions of the Myocardium<sup>1</sup>

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Calcification of the heart muscle was first demonstrated during life, roentgenologically, by Groedel (1), in 1911. In 1924 Scholz (2) published a case which was followed up by autopsy study. Cohen and

servations and called attention to the logical deduction that calcification within the heart takes place only in dead or markedly deteriorated but never in healthy myocardium. This opinion was substantiated by Hanes (6) in his account of a patient who died from parathormone intoxication, exhibiting at autopsy severe degenerative lesions of the myocardium containing deposits of calcium. This condition had been previously described by McJunkin, Tweedy, and Breuhaus (7).



Fig. 1. Postero-anterior film of chest showing the bulge in the upper portion of the left ventricle with the calcified shadow beneath the pericardium.



Fig. 2. Lateral view of the chest showing the lesion illustrated in Figure 1 situated in the anterior portion of the left ventricle.

Levine (3) reported a case in 1937, and in 1938 Parkinson (4) added another, giving an excellent historical review of the subject, with comments on clinical and roentgenographic features of the disorder. In 1943, Borman (5) presented a case with x-ray, kymographic, and electrocardiographic ob-

The following case is reported because it presents three features of exceptional interest. First, the calcification obviously is present in a myocardial infarction which occurred twenty-two years previously, in a patient still carrying on a useful life. Second, the aneurysm was suspected clinically and demonstrated roentgenographically. Third, the patient was approved as a surgical risk because of the absence of congestive heart failure and

<sup>1</sup> From the Departments of Internal Medicine and Radiology, Bowman Gray School of Medicine of Wake Forest College and the North Carolina Baptist Hospital, Winston-Salem, N. C. Accepted for publication in May 1944.



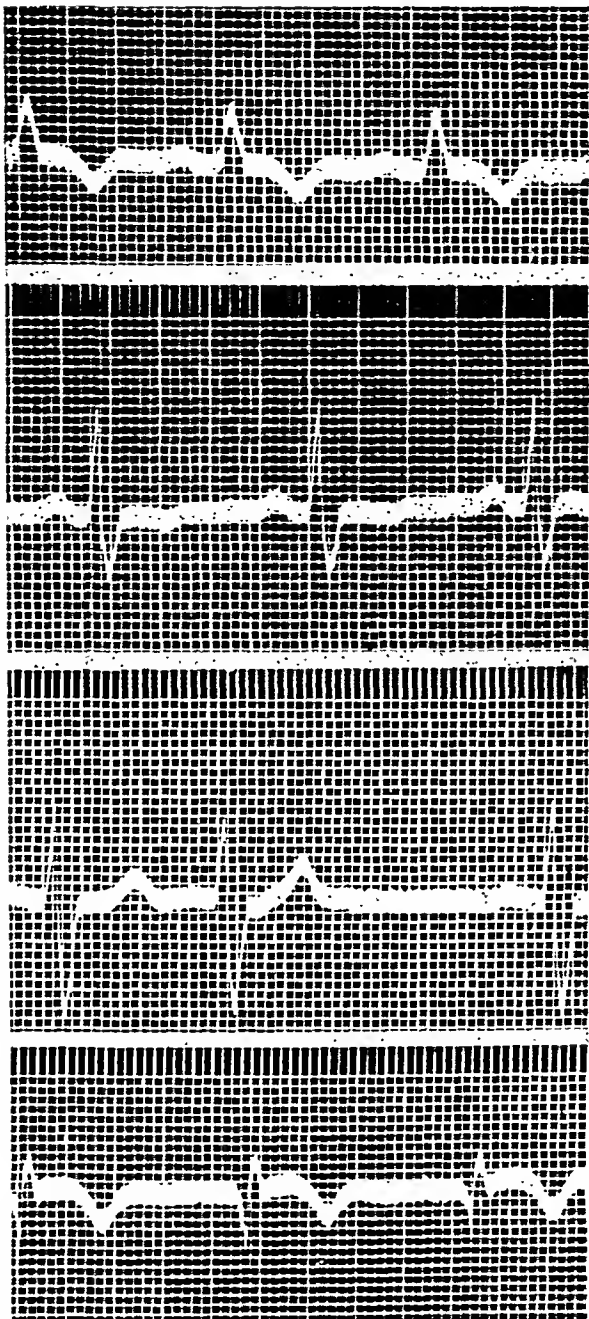


Fig. 3. Electrocardiogram showing the typical findings of an old infarction of the anterior portion of the left ventricle, and also a delay in the intraventricular conduction. Standard limb leads and CF<sub>4</sub>.

withstood transurethral prostatic resection without difficulty.

At the time of this observation, in 1943, the patient was 62 years old and his admission to the North Carolina Baptist Hospital was occasioned by moderate but progressive prostatic obstruction, with 60 c.c. of residual bladder urine. The past history revealed an attack of severe substernal pain which

radiated to the neck and jaws and out both arms to the elbows, occurring twenty-two years earlier, when the patient was forty years of age. The pain lasted several hours, being relieved only after two hypodermics, and the patient was confined to bed for four weeks. He returned to his work as a civil engineer, which he followed under definite physical restrictions without disability, except for slight dyspnea on exertion, up to his present illness.

The patient was seen in consultation by one of us (R. L. M.) for evaluation as a candidate for operation. Physical examination showed a well developed and well nourished man not objectively ill and with no significant findings other than those related to the cardiovascular system. There was mild (grade I) arteriosclerosis. The lungs were clear. In the second left intercostal space, 7 cm. from the midsternal line, was a rocking, forcible impulse slightly preceding the apex impulse. The latter was felt in the fifth left interspace, 10 cm. from the midsternal line. The heart sounds were of good quality, and only a slight systolic murmur was heard at the apex. The liver was not palpable and there was no edema of the extremities. Aneurysm of the left ventricle was suspected on the basis of the abnormal pulsations, and this clinical diagnosis was confirmed by roentgenographic study.

The roentgenological findings in this patient were typical of calcification in the wall of a previous myocardial infarction with left ventricular aneurysm.

Fluoroscopic examination showed a distinct rounded bulge in the left ventricular contour cranial to the left lower pole, which was inseparable from the cardiac shadow in all positions. In the right antero-oblique view, this bulge extended ventrally to the inner border of the sternum. The aorta was moderately dilated, elongated, tortuous, and sclerotic. The lungs were clear.

The pulsations of the ventricle at the site of this bulge were greatly reduced in amplitude and barely perceptible. In addition, a half circle "cup-shaped" ring of calcium, similar to that described by Roesler (8), 2 to 5 mm. in thickness, was seen to encircle the dilated sac. Postero-anterior and lateral films (Figs. 1 and 2) confirmed the screen findings and definitely determined the site of the calcium to be within the myocardium, and not situated at the usual sites of calcium deposits in the pericardium, annulus fibrosus, mitral or aortic rings, or interventricular septum, as described by Sosman (9). The electrocardiogram showed evidence of an old anterior type of infarction of the left ventricle (Fig. 3). The remaining accessory clinical data were normal.

Transurethral prostatic resection was performed under caudal anesthesia and the patient's operative and postoperative courses were uneventful.

While this case has not been studied at autopsy as were the four cases referred to above, we feel that the history, physical

examination, and electrocardiographic findings lead to the diagnosis of myocardial infarction and myocardial aneurysm. X-ray studies demonstrated beyond any doubt the presence of an aneurysm of the left ventricle in which calcification was present.

The finding of such an unusual cardiac pulsation as described above, in the absence of acquired or congenital valvular or other deformity of the heart, should lead one to suspect aneurysm of the left ventricle. This clinical diagnosis must be confirmed roentgenologically.

South Hawthorne Road  
Winston-Salem, N. C.

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# EDITORIAL

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## The Lethal Effect of Whole Body

## Roentgen Irradiation in Animals

From the earliest days of radiology, the lethal effect produced by the exposure of the whole body of an animal to roentgen rays formed the subject of some of the most painstaking and intriguing investigations. It was hoped that through such studies an exact knowledge might be gained as to the uppermost limit of the dose which could safely be tolerated in man and that by subdividing this dose proper values could be established which would lead to the slightest possible systemic reaction in the various therapeutic applications.

The series of these investigations was started in 1904 by Heineke (1), who subjected the entire bodies of mice and guinea-pigs to the effect of rather superficial roentgen rays, the most penetrating that could be obtained with the type of apparatus available at that time. Heineke found that, if large doses were administered, a complete destruction of the lymphatic system developed within twenty-four hours, with subsequent death of the animal. If the dose was smaller, so that the animal did not die, the lymphocytes reappeared in the blood and in a short period they completely regenerated.

Following the initial work of Heineke, other valuable contributions appeared, so that soon a rather significant literature accumulated dealing with various aspects of the problem. The experimental results obtained, however, continued to remain indefinite and often contradictory, due on one side to the lack of constancy of output of apparatus used and on the other to the inaccuracy of the measuring devices. A duplication of the experiments at various sources could be accomplished only with difficulty and at great cost of time.

In the light of newer technical developments, the subject has been retaken during the last few years by several eminent investigators and, fortunately, progress has been much swifter.

Ellinger (2) in 1940, as a preliminary step, studied under well defined and very precise experimental conditions the effect of increasing doses of roentgen rays on the common goldfish (*Carassius auratus*). He found that no changes occurred, as a rule, during the first week following irradiation. In the second or third week the fish became less active, stopped eating, became dyspneic, and eventually died. A dose of 1,500 r of roentgen rays of H.V.L. 0.233 mm. Cu killed all goldfish within nineteen days. If a mortality curve was plotted for the various doses up to that point, this assumed an S shape, similar to that observed in experiments with single cells. All these phenomena occurred with such regularity that Ellinger felt justified in proposing the introduction of goldfish as a biologic test object of the roentgen-ray effect.

In the present issue of RADIOLOGY, Ellinger (3) publishes the results of his experiments with lethal doses of roentgen rays on white laboratory mice and guinea-pigs. To facilitate grading of the effect of the roentgen rays from a more practical standpoint, he differentiates between a *minimum lethal dose*, an amount of radiation producing at least 10 per cent fatalities, an *average lethal dose*, producing 50 per cent fatalities, and an *absolute lethal dose*, producing death of all animals within a given period. It was found that for mice, with use of roentgen rays of H.V.L. 1.25 mm. Cu (200 kv.p., 0.13 mm.

Sn, 0.25 mm. Cu) and rice as backscatter medium, the minimum lethal dose amounted to 200 r in air and the absolute lethal dose to 1,000 r in air given in one seance. Here, too, there was a latent period, but of only two to five days' duration; then the mice showed shaggy fur, loss of appetite, and diarrhea. If the dose was between 200 and 600 r in air, the mice died as a result of these symptoms. When they survived, a return to normal occurred within fourteen to twenty days. If, however, the dose exceeded 1,000 r in air, some mice died on the second day without any prodromal symptoms and the remaining on the third or fourth day with somnolence, dyspnea, and diarrhea. As compared to fish, the life span was also shortened in all instances. According to Ellinger, this shortening of the latent period and life span following increasing doses of roentgen rays is a characteristic of the species and serves as a criterion of differentiation between mammals and fish. The mortality curve for mice followed the same S-shaped pattern as for single cells and fish.

In guinea-pigs, Ellinger noted under exactly identical experimental conditions that the percentage mortality increased progressively with increasing doses of roentgen rays in a manner similar to that of goldfish and mice, but the absolute lethal dose amounted to only 500 r in air. Another notable species difference was the double latent period in relation to mice. Even if a dose as high as 1,500 r in air was administered, the latent period remained six to eight days, while in mice, as already stated, it was two to five days. In this respect the double life span of guinea-pigs, as compared to mice, may have some significance. After the latent period, some guinea-pigs suddenly exhibited severe diarrhea and died within a few hours, the rest showed ragged fur, loss of appetite, and diarrhea and died during the subsequent days. In those which recovered, a restoration to normal occurred within twenty days. A plotting of the mortality curve revealed the same

S-shaped pattern as in all former instances, but the slope appeared much steeper, a fact likewise attributed to the characteristics of the species.

A series of very valuable experiments, along similar lines, was carried out by Henshaw (4). After first studying the effect of single doses of 50 r applied to the whole body of C3H mice, Henshaw subjected to increasingly larger doses of roentgen rays, ranging from 50 to 400 r, the entire bodies of mice of two different strains (C3H and LAF<sub>1</sub>) and guinea-pigs of a single strain. Rigorous technical procedures were observed. The roentgen rays employed were produced with 200 kv., 1 mm. Cu, and all doses were expressed in terms of equivalent air measurements. It was found that guinea-pigs were more susceptible to the irradiation than mice and that there was a difference of susceptibility even between the two strains of mice. Occasionally a guinea-pig died within seven to ten days after a single dose of only 100 r. More than half were killed by doses of 200 r and none survived 400 r. C3H mice were rarely killed by doses of 300 r, 20 to 40 per cent were killed by 400 r, and all were killed by 600 r. All LAF<sub>1</sub> mice survived doses of 400 r, their absolute lethal dose being probably around 600 r. Thus, while there is some difference in the magnitude of the absolute lethal dose in the experiments of Ellinger and Henshaw, a fact which may be attributable to the different types of experimental set-up, in the main the dependence of the lethal effect of roentgen rays on the species specificity seems to be proved beyond doubt.

A closer analysis of the immediate cause of death under the above-mentioned experimental conditions shows that the chief factors responsible are the complete depletion of the hematopoietic system and the irreparable damage done to certain tissues. The variation in the radiosensitivity of the cellular elements and structural components of the body received from the earliest days considerable attention, and through study of the effects of

local or regional roentgen exposures laws have been established which now must be considered fundamental. When the whole body is irradiated, the same laws apply, but here the capacity and extent of recovery of the destroyed tissues also play a paramount role. If a certain vital organ has been irreparably damaged or a certain system irrevocably annihilated, death follows without fail. In general, the younger and more immature a cell or structure, the more apt it is to be destroyed by a smaller dose of roentgen rays. On the other hand, the larger the dose of the roentgen rays administered, the more organs and systems are likely to be put out of function. Ellinger, through a systematic postmortem examination of the killed animals found that the complete destruction of the malpighian bodies of the spleen represented the climax of irreversible damage. Henshaw, who performed very exhaustive hematologic studies as well as numerous histopathologic examinations of the lymphoid organs, bone marrow, and testes, noted that, in a general way, the tissue response consisted of a parenchymatous cell loss. If the damage was not too severe, a slow recovery followed. Regeneration in each case started from primitive cell forms that had survived irradiation fatal to other cells. Leukocyte reserves, especially when the doses were small, prevented the peripheral blood picture from reflecting precisely the condition of the hematopoietic system. If too large a number of the primitive cells were destroyed, recovery of the system became impossible and the animals died. It is interesting that for equal doses, decreasing amounts of tissue damage were seen in guinea-pigs, C3H mice, and LAF<sub>1</sub> mice, in the order given, that is in exactly the same order in which the lethal doses for the respective animals had increased. This variation in injury and recovery of the tissues of the different animals, and even strains of the same animal, accounts for the species specificity if the irradiation is carried out with doses corresponding to the known lethal doses or thereabouts.

An entirely different situation arises, however, when the roentgen exposure of the whole bodies of animals is undertaken with massive doses, representing many times the known lethal dose. Henshaw (5) irradiated C3H mice, guinea-pigs, and rabbits with 25,000 to 50,000 r (200 kv., no filter, 250 r per minute in air, at 50 cm. distance) and found that all animals died within a few hours, some during the actual process of exposure. After irradiation had been in progress about an hour, the animals became restless and breathing was labored; then they showed progressive cyanosis, hyperthermia, and intermittent spastic twitchings. During the last ninety minutes they exhibited periods of alternating stupor and hyperactivity. Strong stimuli would set off sudden, uncoordinated movements. Finally death occurred with the animals lying on their sides in a state of complete spasm. The guinea-pigs as a rule were dead at the end of a three-hour exposure, rabbits within three to six hours after exposure, and the mice within ten to forty-eight hours. Clearly the similar response in all three types of animals to massive irradiation eliminates species specificity. Immediate postmortem examinations revealed extensive degenerative changes of the nuclei and cytoplasm in practically every tissue of all animals, suggesting violent cytolysis irrespective of the species. It is assumed that the sudden release of enormous toxic products evoked a general systemic reaction which completely overshadowed the much slower effect of the functional cell loss.

In this manner, death due to massive irradiation of the entire body is caused by a form of shock. According to Henshaw, the lack of hemoconcentration and the suddenness of death in the acute cases set this type of shock completely apart from that seen in trauma, burns, and various other injuries.

Obviously, further elaborate studies are necessary before the problem is elucidated. With the newer developments of megavoltage roentgen therapy and the continuous

extension of the clinical use of artificial radioactive substances, such studies will acquire more than academic interest.

T. LEUCUTIA, M.D.

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## The Associate Editorship

For some time the Editor has felt the need of the advice and help of an Associate Editor who would be particularly concerned with the problems of radiotherapy, as Doctor Camp, the present Associate Editor, is with diagnosis. The Publication Committee, realizing the complexities of modern radiology, has appreciated the wisdom of such an addition to the Editorial Staff and accordingly requested Dr. Hugh F. Hare of Boston, Mass., to act

in that capacity. It is with great pleasure and satisfaction that we record his acceptance of this post.

Doctor Hare received his training in radiology under Dr. Merrill Sosman at the Peter Bent Brigham Hospital and is now associated with the Lahey Clinic as head of the radiological department. He has made important contributions to the radiological literature, all showing a strong clinical background.



## ANNOUNCEMENTS AND BOOK REVIEWS

### SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

Preliminary announcements have been received of the Second Inter-American Congress of Radiology to be held in Habana, Cuba, Jan. 19-24, 1946, under the presidency of Dr. Pedro L. Fariñas, and a cordial invitation to attend has been extended to the membership of the Radiological Society of North America. The program of the Congress will include four official lectures, scientific sessions, and an extensive scientific exhibit. The formal organization of the Inter-American College of Radiology is scheduled for this meeting.

It is hoped that there may be a large North American delegation present at this Congress and that it may be truly representative of radiology in the Americas. Inquiries for further information should be addressed to the Secretary-General, Dr. R. Hernandez Beguerie, Calle 23 No. 411, Vedado, Habana, Cuba.

### OVERSEAS LECTURES ON BONE AND JOINT RADIOLOGY

Dr. James F. Brailsford of Birmingham, England, having been invited on various occasions to lecture before men of the Medical Services in the U. S. Army stationed in Great Britain, has arranged to present a course of eight or twelve lectures on the various aspects of bone and joint disease, either at one of the hospitals or at the University of Birmingham. "This," he writes, "I do as a small mark of personal appreciation of the help you are giving to us."

RADIOLOGY is glad to make an announcement of this exceptional opportunity for radiologists in the Armed Services now in England and to suggest that those desiring more specific details communicate with Doctor Brailsford, 20, Highfield Road, Edgbaston, Birmingham, 15.

### CANCER TEACHING DAY SARATOGA SPRINGS, N. Y.

Cancer Teaching Day was observed in Saratoga Springs, N. Y., on Jan. 18, under the auspices of the state and county medical societies and the Division of Cancer Control of the New York State Department of Health. The speakers were Dr. Andrew H. Dowdy on "Epithelioma of the Skin," Dr. Gray H. Twombly on "Cancer of the Cervix," Dr. Lloyd F. Craver on "The Significance of Enlarged Lymph Nodes," and Dr. Frank E. Adair on "Diagnosis, Treatment, and Results in Cancer of the Breast."

### In Memoriam

JOHN H. GEMMELL, M.D.

1904-1944

Dr. John H. Gemmell died suddenly on Dec. 2, 1944, in Philadelphia at the age of forty.

Doctor Gemmell was born in Brainerd, Minn. Following his premedical training at Carleton College, he received the degree of M.A. in Physiology from the University of Minnesota in 1926, and of M.D. from the University of Minnesota in 1927. The high quality of his undergraduate work is attested to by his membership in the society of Sigma Xi. He served his internship in the Vancouver Hospital in Vancouver, British Columbia, after which he was resident in radiology in Bellevue Hospital, New York City. He became a diplomate of the American Board of Radiology in 1936.

Doctor Gemmell practised his specialty in Phillipsburg, Penna., in 1930-35, and in Rochester, Penna., in 1935-42. In 1942 he became associated with Doctor W. Edward Chamberlain in the Department of Radiology of Temple University Medical School and Hospital, Philadelphia. On the day of his death he seemed in perfect health and in unusually good spirits, having just returned from a vacation with his wife and daughter.

Doctor Gemmell had many close friends both in and out of organized Radiology. He was widely known for his sound ideas on the problems of medical economics and hospital-radiologist relationships. He was a member of the Radiological Society of North America, the American College of Radiology, and the Pennsylvania Radiological Society. For many years he was Counselor for the State of Pennsylvania, American College of Radiology, and Chairman of the Economics Committee of the Pennsylvania Radiological Society. In 1941 he served as President of the Pittsburgh Roentgen Society. He was elected President of the Pennsylvania Radiological Society in 1943.

W. EDWARD CHAMBERLAIN, M.D.

WILLIAM W. BOWEN, M.D.

1869-1944

Dr. William W. Bowen, a charter member of the Western Roentgen Society, and a member of the Radiological Society of North America until he retired from active practice in 1938 because of ill health, died at his home in Fort Dodge, Iowa, on Dec. 20, 1944, at the age of seventy-five. He was one of the organizers, in 1914, of the Iowa Roentgen Society, which later became the Iowa X-Ray Club. He was President of the Iowa State Medical Society in 1933.





JOHN H. GEMMELL, M.D.  
1904-1944

### OSCAR ROBERT R. TROJE, M.D.

Dr. Oscar Robert R. Troje, for many years chief radiologist at the Employees' Hospital of the Tennessee Coal, Iron and Railroad Co., Fairfield, Ala., died on Dec. 12, 1944, at the age of fifty-nine. Doctor Troje was graduated from the University of Kansas School of Medicine in 1907. He was a diplomate of the American Board of Radiology and a member of the American College of Radiology, American Roentgen Ray Society, and the Radiological Society of North America. He held the rank of Lieutenant Commander in the U. S. Naval Reserve, not on active duty.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**MEDICAL USES OF SOAP. A SYMPOSIUM.** By G. THOMAS HALBERSTADT, B.S.Ch.E., MARION B. SULZBERGER, M.D., THEODORE CORNBLEET, M.D., LESTER HOLLANDER, M.D., C. GUY LANE, M.D., DANIEL J. KOOYMAN, Ph.D., RUDOLF L. BAER, M.D., CAREY MCCORD, M.D., MORRIS FISHBEIN, M.D., AND IRVIN H. BLANK, Ph.D. Edited by MORRIS FISHBEIN, M.D. A volume of 182 pages, with 41 illustrations. Published by J. B. Lippincott Co., Philadelphia. Price \$3.00.

## Book Reviews

**TECHNIC OF ELECTROTHERAPY.** By STAFFORD L. OSBORNE, M.S., Ph.D., Assistant Professor, Department of Physical Therapy, Northwestern University Medical School, and HAROLD J. HOLMQUEST, B.S., B.S. (M.E.), Lecturer in Applied Physics, Department of Physical Therapy, Northwestern University Medical School, Chicago, Ill. A volume of 760 pages, 293 illustrations, 72 tables. Published by Charles C Thomas, Springfield, Ill., 1944. Price \$7.50.

This text was written primarily for the medical and the physical therapy student, physical therapy technician, and practising physician. According to the authors' statement in the preface, the material presented is that used during the last sixteen years in teaching electrotherapy at Northwestern University.

The book is somewhat unusual in that the authors are highly trained, respectively, in what might be regarded as quite diverse fields, namely in physiology and in physics and electrical engineering.

The attempt is made to present basic information concerning electrophysics and physiologic effects of electrotherapy. The subject matter is divided into several sections, as follows: (1) direct current, (2) electrical muscle stimulation, (3) radiation, (4) high-frequency current. In general, each electrical agent is discussed from the standpoint of basic physics, physiology, types of apparatus, and technic of application. Specifically, the section on radiation is devoted to thermogenic agents or heat-producing radiation and ultraviolet light, and the section on high-frequency current includes the technic of administering artificial fever, its uses, and its physiologic effects.

The authors have endeavored to present their material in a manner which would make it useful both to the person who has little basic knowledge, particularly of physics, and also to the highly trained person. The fundamentals of physics are presented in the context, and the more complex physical and mathematical problems are discussed in detailed footnotes, intended to meet the needs of the person who has had considerable education in the field of electrophysics.

In some instances, there is justification for disagreement with the prescriptions for electrotherapy recommended by the authors. No attempt has been made to present specific indications for use of the various types of electrotherapy. This omission may be explained on the basis of the fact that neither author is a physician. Since most of the apparatus shown in the photographs throughout the book are made by one manufacturer, the authors may be criticized unjustly as having been commercially influenced. The contents of the book otherwise do not confirm this supposition. The authors apparently are definitely partial to one procedure in the production of artificial fever by physical means and appear to lack experience with other types of apparatus.

The book is well written, clearly arranged, and adequately documented, and includes a review of most of the recent important experimental work in electrotherapy. It meets a definite need and undoubtedly is the most exhaustive scientific treatise on this particular subject. It is recommended to physicians specializing in physical medicine and to teachers of technical and medical students as essential reading, and to practising physicians and physical therapy technicians as a valuable reference work.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St. Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month; in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 1.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave. Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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Treatment resolves itself into (1) the attempt to remove the area of infection with a surrounding area of good bone, (2) the attempt to prevent the spread of the osteomyelitis to supposedly uninfected bone, and (3) the management of complications.

Prior to operation the roentgenograms are studied so that the amount of bone involved may be determined. The diseased area, with a surrounding healthy zone, is removed in one piece, and its edges, as well as the edges of the remaining bone, are inspected for infected areas. The operative specimen is immediately sent to the x-ray room for a roentgenogram, which may aid in determining whether the infection is all included. When it is thought that all diseased bone has been removed, the operative field is lightly covered with a powdered sulfonamide compound. The incisions are left open. The use of vitallium skull plate promises to be the method of choice for the repair of the deformity caused by the osteotomy.

There were 2 deaths in the author's series, both in cases complicated by massive subdural abscess. These cases are summarized.

### THE CHEST

**Accidentally Discovered Pulmonary Tuberculosis.** Hans Abeles and Max Pinner. *Am. Rev. Tuberc.* 49: 490-500, June 1944.

With the widespread use of mass x-ray surveys of the chest among apparently healthy persons, evidences of pulmonary tuberculosis are discovered in many who are without symptoms of disease that might induce them to seek medical advice. In a considerable percentage of these, the diagnosis of the activity of the process is neither readily made nor excluded. During the past few years the authors have observed 91 patients whose tuberculosis was discovered accidentally. These patients were observed in a routine way, with emphasis on all those observations which seem likely to answer the question "active or non-active?"

An analysis of the results of this study shows that there are three criteria for activity which have a high degree of reliability: (1) radiographic instability, (2) properly related symptoms, (3) bacterial findings. In contrast to these, the sedimentation rate failed in about 40 per cent to determine the status of the disease, and leukocytosis and physical examination correctly suggested activity in less than half of the active cases. It is emphasized that negative bacteriological findings are significant only if based on numerically sufficient and technically adequate examinations. Thus, 24 of 77 positive findings were obtained only by culture and frequently not by the first culture made; 28 of the positive findings depended upon examination of gastric content. Even in minimally active cases, bacilli were found in nearly 80 per cent.

With regard to significance of symptoms, not all of these patients are asymptomatic, even though the disease was discovered during a mass survey. Careful questioning, not only at the time the lesion is discovered, but subsequently, after mental resistance against acceptance of the diagnosis has been lessened, will determine to a large degree how many of these patients are really asymptomatic. In the present series there were only 16 among 86 patients with active disease who never experienced any symptoms.

L. W. PAUL, M.D.

**Problem of Tuberculosis in Apparently Healthy Man as Shown in the Routine Examinations for Induction into the Armed Forces.** C. Howard Marcy. *Dis. of Chest* 10: 241-245, May-June 1944.

The author stresses the magnitude of the tuberculosis problem, pointing out that approximately 1.9 per cent of all men passing through the Induction Boards are rejected for military service because of this disease. In Pennsylvania alone the number has exceeded 15,000.

From a medical standpoint the rejectees are divided into three groups: (1) those with minimal healed lesions; (2) those with demonstrable disease of undetermined stability; (3) those with unquestionably active disease. Men in the first group can in many instances return to their former civilian occupations with safety, but they should receive advice as to the significance of their condition, with a view to dispelling unfounded fears. The second group requires thorough study, sound medical advice, and prolonged follow-up, while the third group demands hospitalization.

The responsibility for the care of these tuberculous rejectees rests with the medical profession. It must take an intelligent interest in the problem if the effective case-finding program established in the Armed Forces is not to lose its value for the prevention and control of tuberculosis in the civilian population.

HENRY K. TAYLOR, M.D.

**Occurrence of Pulmonary Tuberculosis in Supposedly Screened Selectees.** Arden Freer. *Dis. of Chest* 10: 197-207, May-June 1944.

The object of the Army Regulations in regard to tuberculosis is to screen out of the service men with active and potentially active lesions which would interfere with the effective performance of their duties or later become a cause of disability. The present Regulations specifically exclude from military service not only those with any type of tuberculosis believed to be active, but also those with scarred infiltrative lesions exceeding a total area of 5 sq. cm. as seen in conventional flat films. Those with arrested lesions measuring less than 5 sq. cm. may be accepted for service if stability of the lesion has been demonstrated by at least six months' observation. Those with small calcified primary complexes are accepted without question, while acceptance or rejection of those with large or multiple foci is dependent upon the judgment of the medical examiner.

Early published and unpublished statistics from authoritative sources show a rejection rate of something over 1 per cent for pulmonary tuberculosis. Not only has x-ray examination been effective in screening out these cases, but it has been of value also in discovering significant non-tuberculous disease.

The efficiency of the procedure for screening out tuberculosis, in spite of the large number of cases detected, has been far from perfect. It was estimated from the re-examination of more than 53,000 films representative of a considerable number of induction stations that approximately 1,500 cases per million men were being missed. An analysis of admissions to the Fitzsimons General Hospital is also indicative of the failure of the induction examination to eliminate all cases. Missed diagnoses are attributed to inexperience, speed, fatigue, monotony, and clerical errors.

But while some cases of tuberculosis have escaped

discovery prior to induction, symptoms or subsequent routine Army examinations have resulted in discovery of the majority of these cases before great advance has occurred. A recent survey indicated that approximately 30 per cent were detected within a month and nearly 80 per cent within six months. Furthermore, routine chest films are required on discharge from the Army, and it may be reasonably expected that this will lead to the discovery of the vast majority of cases previously missed or developing during military service.

"More than 10 per cent of the total population of the country will have been x-rayed in the physical examinations incident to military service. Approximately 150,000 men will have been rejected for tuberculosis. Thousands of these open cases will undergo treatment with resultant arrest of a great number and prevention of further spread of the disease."

HENRY K. TAYLOR, M.D.

**Studies of Rejectees for Thoracic Abnormalities.** Wm. A. Hudson and David S. Brachman. *Dis. of Chest* 10: 234-240, May-June 1944.

Between March 28, 1942, and June 30, 1943, 1,109 "chest rejectees" from the Wayne County (Michigan) Selective Service Draft Board, were examined for thoracic abnormalities. Of this group, 139 (12.4 per cent) gave a history of previous treatment for tuberculosis; hospitalization was recommended for 114 (10.3 per cent); 93 (8.4 per cent) were found to be normal. The number with reinfection tuberculosis was 787. Six hundred and nine cases of this group were classified as inactive, and in many of these a change of occupation was recommended to prevent future reactivation.

An interesting feature of this study is a comparison of the reinfection tuberculosis findings among the rejected men with observations on a group of 34 senior high-school students with tuberculosis, 21 cases from a housing project for homeless, unemployed men, and 147 cases discovered by the "usual means" (examination of patients with suggestive symptoms and of contacts) by the Detroit Department of Health. The figures for the rejectees showed 61 per cent minimal, 31 per cent moderately advanced, and 8.0 per cent far advanced lesions. Among the high-school students, 82.4 per cent had minimal and 17.6 per cent moderately advanced disease. The percentage of minimal lesions for the unemployed men was 52.4 per cent, and for those discovered by the "usual means" only 19.1 per cent.

A consideration of these figures, more particularly those for the rejectees and students, with their comparatively high percentages of minimal lesions, and the "usual means" group, with its low percentage, lends new emphasis to the value of mass surveys.

HENRY K. TAYLOR, M.D.

**Tuberculosis as a Navy Problem.** Dean F. Smiley and Herbert A. Raskin. *Dis. of Chest* 10: 210-233, May-June 1944.

A statistical historical presentation is given of the progress of the battle against tuberculosis in the U. S. Navy. Included are 13 tables and 8 graphs showing the advances made, more especially since 1926. During the past forty-three years there has been a gradual reduction in the rate for "original admissions" to the sick list for tuberculosis, until in 1942 the rate was one-tenth of that for 1900. A sudden rise in admission rates and

invalidings from the Service at the beginning of the present war is directly attributable to chronic arrested disease discovered through the greatly expanded utilization of roentgen examination of Navy personnel. The incidence of tuberculosis is about the same in the forces afloat as in the forces ashore. From an occupational standpoint, the culinary, hospital corps, and engine groups showed a higher incidence than others.

A real advance toward eliminating tuberculosis from the Naval Service was made with the inauguration of roentgen examinations of the chest as a prerequisite to entrance into the Navy. To the present program of preinduction chest radiography and radiographic examination upon the advent of clinical symptoms, the authors would add (a) periodic chest radiographic studies of all hands at intervals graded to the risk of exposure and the severity of the duty, supplemented by clinical studies including tuberculin testing when indicated; (b) special studies of the factors operative upon the hospital corps, culinary and engine room groups which might conduce to tuberculosis; (c) an increased appreciation on the part of all Navy medical officers of the importance of the chest roentgenogram in the prompt establishment of a diagnosis of pulmonary tuberculosis.

"Given these additions, it would appear that the U. S. Navy, in the not too distant future, may fully realize the attainment of its goal—utter annihilation of tuberculosis."

HENRY K. TAYLOR, M.D.

**Pulmonary Tuberculosis in Navy Recruits.** Robert Shapiro. *Am. Rev. Tuberc.* 49: 485-489, June 1944.

Chest examinations of Navy recruits have been done by the photofluorographic method. This procedure was chosen because of its rapidity, its inexpensiveness, and the ease and simplicity of filing the films. The present report analyzes briefly the results in 50,100 consecutive examinations. Calcified lesions in the lung parenchyma, the hilar lymph nodes, or in both locations, were found in 10.7 per cent of the men examined. Of the 5,323 recruits with such evidence of calcified primary tuberculosis, 25 or 0.47 per cent were rejected because of the large number or massive size of the calcifications.

Of the total number of recruits examined, 420 (0.86 per cent) showed evidence of a reinfection type of pulmonary tuberculosis. No attempt was made to differentiate radiologically between active and healed tuberculous lesions in this category, but in 19 cases there was frank cavitation. All of the examinations on which this report was based were performed on men seeking admission to the Naval Construction Battalions, popularly known as the Seabees. A fair proportion of the men, therefore, were in the fourth and fifth decades of life, and in this respect they differed somewhat from the average Navy recruit, who is more likely to be in the second or third decade. The lesions which are considered as sufficient cause for disqualification are as follows:

1. Any evidence of reinfection (adult) type of tuberculosis, active or inactive, exclusive of slight thickening of the apical pleura.
2. Evidence of active primary (childhood) type of tuberculosis.
3. Inactive primary pulmonary tuberculosis, if the degree or extent of involvement appears to be of present or future clinical significance.



4. Extensive multiple calcification in the lung parenchyma and massive hilar calcification.

5. Evidence of fibrinous or serofibrinous pleuritis.  
L. W. PAUL, M.D.

**Tuberculosis Among Hospital Personnel.** William G. Childress. *Am. Rev. Tuberc.* 49: 501-509, June 1944.

Routine periodic chest x-ray examination of all employees in the Tuberculosis Division of Grasslands Hospital, New York was begun in 1932. In 1938 this type of examination was extended to employees throughout the general hospital. Grasslands is an 800-bed general hospital, with 300 beds for tuberculous patients housed in separate buildings. For the present study, work histories of 5,039 patients were obtained; of these, 3,700 had received one or more roentgen examinations of the chest; 2,092 were known to have been exposed to tuberculosis in the course of duty, while 2,947 were not exposed to known sources except as might be expected in a general hospital service.

Of the total number of persons examined, 45 who were originally symptom-free, with normal roentgenograms of the chest, were subsequently found to have tuberculosis; 39 of these were among those exposed to known sources of infection, while 6 had not been so exposed. In addition to this group, there were 14 employees in whom active lesions were found at the original x-ray examination; 57 per cent of these had been exposed for an average of 4.9 months prior to the examination and 43 per cent had not been exposed. There was another group of 88 persons in whom latent lesions were discovered on the first examination or on follow-up studies. A final group of 65 employees gave a previous history of tuberculosis; 51 of these were exposed to tuberculosis during employment, and in 14 (27 per cent) the lesions were reactivated; 14 were not exposed, and in 3 (21 per cent) of these there was reactivation.

Combining all of the groups, it is seen that a higher morbidity occurred among those exposed than among those who were not exposed. Of particular importance were the 45 symptom-free, roentgenologically negative patients in whom tuberculosis subsequently developed. In this group the morbidity was approximately seven times as great in the exposed as in the unexposed, and this incidence was higher regardless of age.

In an attempt to detect undiscovered tuberculosis among patients, routine fluoroscopic and chest x-ray examinations of 7,187 persons admitted to the hospital or its out-patient department were made from July 1, 1941, to Jan. 1, 1943. Of these, 201 (2.8 per cent) had evidence of reinfection tuberculosis, and of this number 42 (0.6 per cent) had active disease or x-ray lesions where activity could not be excluded.

The results of this study indicate that tuberculosis control programs should be designed to discover active tuberculosis in hospital personnel and also in hospital patients, so that active cases may be isolated and treated and protection given to those not already infected.  
L. W. PAUL, M.D.

**Importance of Bronchography in Cases of Unresolved Pneumonia.** George S. Grier, III. *Arch. Int. Med.* 73: 444-448, June 1944.

Routine roentgenography of the chest has kept most men with pulmonary tuberculosis from being inducted into the Army; but normal roentgenograms of the chest

do not exclude bronchiectasis, and many cases of this condition are not detected. The authors seek not only to point out the importance of bronchography in cases of unresolved pneumonia, but also to show that frequently pneumonitis secondary to bronchiectasis is misdiagnosed as primary atypical pneumonia.

Forty patients with bronchiectasis, with an average age of twenty-six and one-half years, were admitted to the Station Hospital at Fort Eustis, Va., during a period of fifteen months. Nine of these patients were referred to the chest clinic because of a history of chronic cough, hemoptysis, or recurrent chest colds, while the remaining 31 (77.5 per cent) were admitted to the hospital with an initial diagnosis of primary atypical pneumonia.

The symptoms on admission, in order of frequency, were cough, mucopurulent sputum with occasional blood streaking, substernal soreness, chills, fever, and sweats. Examination showed slight impairment of resonance, suppressed breath sounds and fine, crackling, and coarse râles in the lower lobe of one or both lungs. A leukocytosis was present, with little increase in polymorphonuclear neutrophils. X-ray examination demonstrated stringy and mottled densities in the lower lobes of the lungs, usually unilateral and radiating out from the hilum toward the diaphragm. Lateral roentgenograms of the chest frequently revealed a pneumonic process behind the diaphragm or a cardiac shadow which could not be seen in the posterior-anterior view.

Bronchographic studies were done in cases in which resolution failed to occur in four to six weeks, and iodized poppyseed oil was injected into both sides even when the pneumonic process was unilateral. (Studies with iodized oil are contraindicated during acute pneumonitis, since this procedure may produce an exacerbation of the acute process.)

The technic of bronchography is given. In 30 cases the distribution of the bronchiectasis was found to be unilateral; in 20 cases it involved the lower lobe of the left lung. Tubular (19 cases) and fusiform (15 cases) dilatations were the most frequent types of bronchiectasis demonstrated; the saccular form (6 cases) was seen rather infrequently. Nine patients in this series showed extensive bronchiectasis, 20 moderately severe, and 7 mild; only 4 had localized disease.

The author concludes that bronchographic studies should be done in all cases of pneumonia which fail to resolve in a reasonable period (four to six weeks).

**Primary Atypical Pneumonia, Etiology Unknown: Average Clinical Picture Based on Thirty-Seven Original Cases.** Richard H. Smith. *Ann. Int. Med.* 20: 890-902, June 1944.

The present study is based on 37 cases of atypical pneumonia seen between January 1941 and October 1942. The disease is referred to in this paper as "primary, atypical pneumonia, etiology unknown," which is the designation assigned by the Commission on Pneumonia of the U. S. Army. Among other designations in the literature are "virus pneumonia, type A," "acute pneumonitis," "acute respiratory tract infection, type A," "acute interstitial pneumonitis," "brouchopneumonia of unknown etiology, variety X," "current bronchopneumonia of unusual character and undetermined etiology," "virus-type pneumonia," "viral pneumonia," and many others. The causative organism has not been identified. Attempts to demon-



(3) *Nodulation*: Usually the nodules, not over 3 or 4 mm. in diameter, which constitute the characteristic tissue reaction of silicosis, are evenly distributed throughout all parts of both lungs. In long-standing cases, the costophrenic angles are often clear, due to the development of emphysema.

(4) *Massive Conglomerate Nodulation*: The writer subscribes to the South African view that the presence of large localized areas of conglomeration in a film showing nodulation constitutes evidence of associated infection, which so injures the lung that more silica is retained. Massive conglomerate lesions usually occur in the upper portions of the lungs; they may be bilaterally symmetrical; they may radiate outward from the hila. Sometimes they involve the lower lungs.

In addition to the four patterns mentioned above, the author describes a "*diffuse haze to ground glass appearance*," which is most commonly associated with early asbestosis and with some other less known types of pneumoconiosis. In early cases such shadows spread over the lower lung fields to more or less obscure the normal markings. As the disease advances, the haze becomes more dense and extends upwards. In fully mature cases of asbestosis all vascular markings are obliterated in the lower two-thirds of the lung fields by a widespread uniform density composed of confluent minute stippled shadows.

Unilateral patterns are presumably not due to dust inhalation. It should always be kept in mind that a poor film, especially one taken short of full inspiration, produces artefacts that may be mistaken for evidence of pneumoconiosis.

*Physical examination*, which constitutes the third essential in the diagnosis of pneumoconiosis, includes the usual procedures plus a carefully given exercise tolerance test. In general, symptoms are most severe in the massive conglomerate form. Most of these patients are short of breath, some even at rest. The symptoms and signs are those of emphysema and chronic bronchitis.

*Treatment* is essentially prophylactic. Mention is made of the employment of aluminum dust inhalation as a preventive measure in workers exposed to silica dust. If enough aluminum is inhaled it will neutralize the quartz effects. While it will not cause preformed silicotic nodules to disappear, earlier tissue reactions may resolve. Aluminum inhalation should not, however, be allowed to replace good hygienic control.

PERCY J. DELANO, M.D.

**Roentgenograms of the Chest Taken During Pertussis.** Jerome L. Kohn, Irving Schwartz, Jerome Greenbaum, and Mary M. I. Daly. *Am. J. Dis. Child.* 67: 463-468, June 1944.

A study was made in the Willard Parker Hospital (New York) of repeated roentgenograms of the chest in 222 cases of pertussis in children from the age of five months to eight years. These examinations were made fourteen to twenty-one days after the onset of symptoms and many showed evidence of peribronchial infiltration, pneumonic consolidation, and atelectasis.

The patients were divided into three groups: those with no fever, those with low-grade fever, and those with high fever. Normal roentgenograms were obtained in some patients of all three groups. The incidence of pulmonary abnormalities was much greater, however, in patients who had fever. The most frequent site of atelectasis and consolidation was the right

middle lobe. The secretion in pertussis is known to be tenacious and viscous. The bronchus of the right middle lobe is smaller than those in the upper or lower lobes. The authors believe these conditions contribute to frequent atelectasis with secondary infection in this lobe. Roentgen evidence of enlarged tracheobronchial lymph nodes was infrequent, which was in keeping with autopsy findings. Physical findings were not so great as would be expected from the roentgen findings.

LESTER M. J. FREEDMAN, M.D.

**Atelectasis Complicating Acute Poliomyelitis with Involvement of Respiratory Muscles.** M. Cooperstock. *Am. J. Dis. Child.* 67: 457-462, June 1944.

In paralysis of the respiratory muscles due to poliomyelitis, a number of factors predispose to the development of atelectasis with its accompanying danger of bronchopneumonia. Foremost among them is the reduction of vital capacity which results not only from respiratory muscle paralysis but from lack of general muscle tonus. The cough reflex is impaired in proportion to the involvement of the anterior horn. Adequate bronchial drainage is also interfered with by actual reduction in size and motility of the bronchi in a hypoventilated lung. The lower lobes may, in addition, be subject to compression from below by a paralyzed diaphragm. Atelectasis occurs when secretion plugs a bronchus, which in turn provides a fertile soil for the development of secondary pneumonia.

Four well illustrated cases are reported. Atelectasis occurred in these patients three weeks to one year after admission to the hospital, well after the acute stage of poliomyelitis had passed. Signs and symptoms of pneumonia developed after the atelectasis except in one instance where the infection was present two days prior to the pulmonary collapse. All patients were given sulfonamide therapy and were using the Drinker respirator. One patient died.

Avoidance of exposure to respiratory infection is an important prophylactic measure. Early administration of sulfa medication is urged at the first indication of pneumonia. The continued use of a mechanical respirator is advised, especially where there is disturbance of the cough reflex. The one death reported is attributed to the delay in instituting sulfa therapy and to interruption in the use of the Drinker apparatus. Early drainage by bronchoscopy is suggested and considered useful but was not employed in this series.

LESTER M. J. FREEDMAN, M.D.

**Spontaneous Pneumothorax Complicating Bronchial Asthma. Report of Two Cases and Consideration of Possible Mechanisms Involved in Its Production.** Mason Tröwbridge, Jr. *Arch. Int. Med.* 73: 460-465, June 1944.

Spontaneous pneumothorax as a complication of bronchial asthma occurs chiefly in young persons, of both sexes. The mode of onset is variable. Dyspnea is usually present and subjectively different from that ordinarily accompanying asthmatic attacks. Pain is an almost constant feature, but it may be absent, particularly in cases of recurrent pneumothorax. It is usually pleural and may radiate to the flank; a sense of constriction in the chest is frequently noted. Left-sided pneumothorax is slightly more common than right. In some cases there are no physical signs suggesting a pneumothorax.

Two cases of bronchial asthma complicated by spont-



The onset may be insidious, with upper respiratory infection and slight fever, or it may be abrupt with chills and fever. Chest pain and hemoptysis are common. The sputum soon becomes purulent. Toxemia is variable. The chief complication is rupture into the pleural cavity.

The non-surgical treatment is postural drainage with general sanitarium care as for tuberculosis.

SYDNEY J. HAWLEY, M.D.

**Dermoid Cysts and Teratomata of the Mediastinum.** N. Lloyd Rusby. *J. Thoracic Surg.* 13: 169-222, June 1944.

Six new examples of proved dermoid cyst or teratoma of the mediastinum are recorded. An extensive and well organized summary of the world literature is presented, and a complete bibliography is included. Roentgenograms of four of the cases are reproduced.

The first tumor of this type recorded was made the subject of an address to the Medico-Chirurgical Society of London on Nov. 25, 1823, by J. A. Gordon. Up to the end of 1939, 245 cases had been reported.

The position of these tumors is in the anterior mediastinum, but they generally encroach on one or other side of the thorax. There are two types: the dermoid type and the solid type. The dermoid is the simpler and commoner, consisting usually of one cystic cavity containing sebaceous material. Microscopically it is simple and benign but may become malignant. The solid teratomata contain all three germinal layers and are more prone to be malignant. They are the source of 70 per cent of the malignant tumors of this type.

A long discussion of the pathogenesis, clinical features, physical findings, sputum examinations, etc., is presented, but need not be abstracted here. In the radiological discussion the following points are brought out. It is expected that many more of these tumors will be discovered by the mass chest surveys now being conducted. A lateral view is essential in addition to the usual postero-anterior projection. The tumors have a clear-cut edge and are usually circular or globular but may be irregular and lobulated. Calcification, teeth, or plaques of bone may be present. Fluid levels may be observed when bronchial communication exists and, even in the absence of air, a level has occasionally been demonstrated due to separation of the fat in the cyst from the aqueous content. Bronchography helps very little in the diagnosis but may be of value in showing the presence of bronchiectasis as a complication. Kymography and tomography have been of little value. Fluoroscopy is valuable in locating the mass.

The Aschheim-Zondek test may prove useful in differential diagnosis when positive. Bronchoscopy is of little value. A complete discussion of the differential diagnosis is presented. The paper is completed with a long discussion on the complications and treatment. Surgical removal is advised in all cases unless contraindicated for other reasons. There is no known instance of cure of a malignant teratoma.

HAROLD O. PETERSON, M.D.

**Rheumatic Pericarditis in Early Childhood.** Samuel L. Ellenberg and Harold Cook. *J. Pediat.* 24: 662-670, June 1944.

A case of rheumatic pericarditis in a colored boy, 2 1/2 years of age, is reported. This patient is the

youngest on record to have recovered from this condition.

On the night before admission to the hospital, the child, hitherto perfectly well, suddenly complained of generalized abdominal pains. Four hours later he was feverish and breathed with difficulty. He appeared acutely ill when first seen, with labored respiration, hypertrophied and congested tonsils, and injected pharynx. The abdomen was moderately distended and somewhat rigid but there was no localized tenderness. Rectal examination elicited tenderness on the right side. A roentgenogram of the chest was normal.

On the day following admission a diminution of the percussion note anteriorly and posteriorly in the left lower lung field, with a corresponding decrease in breath sounds, was noted; this was interpreted as indicating an early lobar pneumonia. X-ray examination of the chest now showed enlargement of the cardiac silhouette, especially on the left side, with clear lung fields, and an electrocardiogram confirmed the clinical impression of rheumatic pericarditis. The heart at this time was enlarged, the heart sounds did not appear muffled, a friction rub was not heard, and no murmurs were present.

Despite large doses of salicylates, the size of the heart continued to increase. The child was very dyspneic even in the oxygen tent, and restlessness had to be controlled with morphine and sodium phenobarbital. Rapid digitalization was employed when the liver became tender and the first evidences of congestive failure presented themselves, but no appreciable effect of this medication was observed. On the sixth day 10 c.c. of pericardial fluid was withdrawn; this proved to be sterile but showed a leukocyte count of 8,000, with 80 per cent lymphocytes.

A pericardial friction rub and muffled heart sounds were first heard one week after admission, when the clinical findings and roentgenograms indicated an increase in the size of the heart. The general condition became much worse; on the fourteenth day, edema of the ankles appeared. On the seventeenth day the patient began to improve: the edema of the ankles subsided, the dyspnea disappeared sufficiently to enable him to stay out of the oxygen tent, and the toxicity decreased. On the twenty-first day of the illness a systolic murmur, not transmitted, was heard for the first time at the apex, and the cardiac shadow appeared normal in size except for widening of the superior portion. At the time of the patient's discharge, a faint soft systolic murmur at the apex, not transmitted, was the only indication of possible cardiac damage. At the last follow-up examination, nine months after the onset of the illness, roentgen and laboratory studies were essentially normal.

This case presented a difficult diagnostic problem. During the first two days the abdominal pain and toxemia were so strongly suggestive of an acute condition of the abdomen that surgeons were twice called into consultation. The second x-ray examination of the chest, the day following admission, led to the correct diagnosis. Roentgenograms are reproduced.

**Purulent Pericarditis Complicating Pneumonia. Recovery in an Infant Following Therapeutic Aspiration and the Development of Pneumopericardium.** M. Cooperstock. *J. Pediat.* 24: 656-661, June 1944.

A case of purulent pericarditis complicating pneumonia in an 8-month-old infant is reported. The pa-



postoperatively. If they are rested for six days, a good sear without thinning usually results.

Radiological demonstration of the aneurysm is the most valuable of all diagnostic aids. Fluoroscopic screening not only aids in determining the site of the aneurysm, but also reveals the type of pulsation. Paradoxical pulsations indicate a weakened area of myocardium, while diminished pulsations may be observed if the aneurysm is filled with organized clot or surrounded by thickened pericardium.

Fluoroscopic screening also enables the best position to be found for taking x-ray pictures. Thus a lesion of the anterior wall is best seen in the antero-posterior and right oblique positions; if the aneurysm projects forward, either it may appear as a distinct bulge, or more often its upper margin forms a more or less abrupt ledge or shelf on the anterior contour of the heart. If the posterior wall of the heart is affected, an antero-posterior film may reveal a diffuse bulge at the upper part of the left ventricular border, usually separated from it by a notch; these aneurysms are, as a rule, at a higher level than those on the anterior wall. A film in the left oblique position reveals a posterior projection from the upper part of the left ventricle indenting the barium-filled esophagus. The density of posterior aneurysms may be the same as, but is frequently lighter than, the cardiac shadow.

Infarction of the membranous septum may yield to form an aneurysm bulging into the right ventricle; this results in gross enlargement of the right side of the heart with no apparent cause.

Sometimes x-ray examination will reveal calcification within the left heart border or in the clot. This calcification is limited to the left ventricle and is linear, whereas in chronic constrictive pericarditis the calcification is thicker, more irregular, and not restricted to the ventricle.

The author reports a case in a fifty-three-year-old white male, which had been under observation for a period of twenty-one months.

ELLWOOD W. GODFREY, M.D.

## THE DIGESTIVE SYSTEM

Major Motility Patterns of the Child's Digestive Tract: A Review. Irving J. Wolman. *Am. J. M. Sc.* 207: 782-804, June 1944.

This is a useful review of recent contributions to the subject of major patterns of digestive tract motility in infancy and childhood. The bibliography contains 124 references.

Incidence of Peptic Ulcer. Marcel Patterson. *New Orleans M. & S. J.* 96: 570-591, June 1944.

That peptic ulcer is a common disease is widely recognized. Yet when one attempts to analyze the data of various authors on its incidence, one is struck with the extreme lack of agreement. This discrepancy is explained, at least in part, by the variation in geographic conditions and lack of uniformity of method used in conducting the surveys.

The author has made an exhaustive review of statistical surveys in an attempt to determine the frequency of peptic ulcer in this country and in other countries, the anatomic incidence of ulcer, its sex and age incidence, occupational incidence, incidence in various body types, and incidence of complications.

Reported large series in America show a wide variation from 0.06 per cent (clinical diagnosis) of hospital admissions, to 20 per cent (x-ray diagnosis) in consecutive gastro-intestinal examinations. The percentage of ulcers found at autopsy occupies a midway position between the two extremes. It is believed that many patients with unrecognized ulcer are admitted to hospitals for other conditions. The author concludes that in America approximately 12 per cent of all persons have peptic ulcer sometime in their lives.

Foreign statistical reports show great variability in the incidence of peptic ulcer from country to country. The reported incidence in necropsy material, as given by Rutimeyer (1906), is surprisingly low in Russia, 0.8 per cent, while in Denmark it is 16.7 per cent. Peptic ulcer is common in India, but is reported to be 15 times more common in the southern than in northern part. In the native Malays of Java and Sumatra the incidence is very low, while among the Chinese of this region the frequency is more or less the same as in the western world. Statistics for other geographical areas are cited from the literature.

The ratio of gastric to duodenal ulcer is estimated at 1:4. In America and England peptic ulcer predominates in the male in the ratio of approximately 4:1, and predominance in the male holds for other countries except Java.

Laborers and unemployed classes showed the highest occupational incidence in most series. The opinion, frequently held, that ulcer is more common among people with greater responsibility and mental strain still awaits proof. There is no reliable evidence that a body type peculiar to peptic ulcer exists. Hemorrhage is the most frequent of reported complications, but perforation is more serious.

The unusually high incidence of peptic ulcer in the Armed Forces in this war (30 per cent or over of cases of dyspepsia) indicates it to be a problem of national importance. It is probable that the war has merely called to attention numerous cases of ulcer which existed previously but were not recognized.

A bibliography of 82 references is appended.

H. H. WRIGHT, M.D.

Perforated Peptic Ulcer. A Follow-Up Study of One Hundred Cases. Ashbel C. Williams. *New England J. Med.* 230: 785-790, June 29, 1944.

This investigation was undertaken to determine the fate of persons operated upon for perforated peptic ulcers. One hundred cases were re-studied with this object in mind.

There were 97 males and 3 females in this series. Twenty-seven were in the fourth decade and 32 in the fifth decade of life. In 54 cases the ulcer was gastric, with 42 prepyloric; in 40, duodenal; and in 3, pyloric. In all cases the ulcer was on the anterior wall.

The follow-up results were graded as excellent in 28 cases, good in 27 cases, fair in 22 cases, and poor in 23 cases. It was found that the longer the pre-perforation period of complaint, the poorer the result. The relation of diet to postoperative symptoms seemed to be of limited significance, although indiscretions in eating appeared to precipitate symptoms in some patients.

Postoperative x-ray examination showed complete agreement with the symptomatology in 69 per cent of the series, slight divergence in 14 per cent, and com-



plete disagreement in 16 per cent. The disagreement was believed to be due to the difficulties of examining postoperative stomachs and possibly to the presence of silent ulcers.

Three patients had a second perforation. In one patient a carcinoma developed, apparently in a gastric ulcer, after two years of freedom from symptoms and a negative x-ray examination.

JOHN B. McANENY, M.D.

**Duodenal Diverticulum Simulating Gallbladder Colic. Report of a Case.** Hugh F. Hare and Richard B. Cattell. *S. Clin. North America* 24: 635-639, June 1944.

A patient with symptoms of gallbladder colic, namely pain in the right upper quadrant radiating to the right shoulder and associated attacks of jaundice, was found at operation to have a duodenal diverticulum containing stones. Though this patient had had three previous operations and numerous gastro-intestinal x-ray studies, the diverticulum had not previously been detected. It did not fill at the time of the fluoroscopic examination and was overlooked in the original interpretation of the films. A careful review of the six-hour film, however, revealed a diverticulum measuring  $3 \times 4$  cm. in the only portion of the proximal bowel which contained residual barium. The neck of the diverticulum was not clearly shown, but at operation the narrowed neck of the proximal portion was noted.

The importance of studies of the common duct and duodenal loop in cases of unexplained obstructive jaundice following cholecystectomy is emphasized. In most instances the cause of the obstruction is in the common duct, but a duodenal diverticulum containing gallstones may produce symptoms of obstruction, as shown by the case presented.

**Mesenteric Pouch Hernia Simulating Paraduodenal Hernia.** Ray B. McCarty and Arthur J. Present. *Surg., Gynec. & Obst.* 78: 643-648, June 1944.

A 27-year-old soldier, complaining of abdominal pain and tenderness, was admitted to an Army Hospital. During the previous three months he had experienced two attacks of acute abdominal pain, and a feeling of heaviness in the lower abdomen persisted. Roentgen study showed the small intestine coiled in a circular mass, which led to the diagnosis of probable paraduodenal hernia. At operation a broad and thickened duodenojejunal fold was found overlying the mouth of a large mesenteric sac, which contained practically the entire small bowel with the exception of a very short proximal loop of jejunum and the terminal three feet of ileum. The opening of the sac did not involve the duodenum and was anterior to the mesenteric vessels. The wall of the sac consisted of two layers of thinned-out peritoneum, formed by a pouching of the proximal jejunal mesentery.

The origin of this hernia is believed to have been an unusually long pre-arterial mesentery in the region of the proximal jejunum, which formed a pouch during the second stage of embryonic rotation which engaged the small intestine. The small bowel was then incarcerated by the early fusion of the upper jejunum, as represented by the thickened duodenojejunal fold found at operation. Then, as growth proceeded, the hernia enlarged.

No characteristic symptoms are noted in mesenteric pouch hernias. Occasionally there is a history of repeated attacks of intestinal obstruction suggestive of

recurrent temporary volvulus, but the majority of cases reported have been found at autopsy or incidentally in the course of abdominal operations, and have given no previous history of gastro-intestinal distress. Rarely a soft mass has been felt in the abdomen, but this in itself cannot lead to the diagnosis.

Roentgen examination often makes diagnosis possible. The grouping of the small bowel loops in the sac, their failure to separate on palpation, and their lack of essential change in relationship on change of position of the patient, all lead to the fluoroscopic diagnosis. Films made with the patient upright indicate an absence of small bowel loops in the pelvis and flanks; lateral films made in the upright position show the "pocketing" of the loops within the sac. As the result of inclusion within the confining sac, motility of the bowel is decreased, and the barium progresses slowly. The condition may be confused with peritoneal adhesions or a short mesentery, but adhesions should show sharper angulations and a more diffuse pattern. In the presence of a short mesentery, separation of the loops by palpation should be possible, changes in their relationship should follow change of position of the body, and the motility of the bowel should be normal. Pelvic masses may displace the small bowel upward, but pressure from below will produce a convex deformity of the lower margins.

The treatment of hernias in the region of the duodenojejunal juncture is surgical, and an early diagnosis is desirable if it leads to an elective instead of an emergency operation. At times adhesions or vascular structures prevent satisfactory procedures, and the sac cannot always be removed, nor its neck be properly widened. In obstructive cases a lateral entero-anastomosis, an ileocolostomy, or an enterostomy may be necessary without disturbing the hernial sac or its contents.

D. W. TOWNSEND, M.D.

**Intestinal Gas Volumes at Altitude.** Eric W. Peterson, Basil S. Kent, and Howard R. Ripley. *Canad. M. A. J.* 50: 523-526, June 1944.

The transportation of the war wounded by air, particularly those with abdominal injuries or suffering from intestinal ileus or distention, brings up the question of expansion of intestinal gases at altitude. Gas under the influence of reduced pressure at altitude behaves in accordance with Boyle's law. This is evidenced practically in persons accustomed to altitude flying by the frequent occurrence of abdominal distention with concomitant discomfort, both of which are relieved by belching or the passage of flatus.

In the present investigation quantitative methods were applied to the determination of the degree of gaseous expansion and measurement of the possible resistance of the abdominal parietes to the swelling of gas-filled organs with ascent to altitude. A human subject was "decompressed to 30,000 feet" in a decompression chamber after introduction of 400 c.c. of air into the stomach. X-ray films were made with the subject in sitting position at ground level and at intervals of 5,000 feet. At 30,000 feet there was a sensation of fullness in the stomach, promptly relieved by belching. Roentgenograms showed progressive increase in the air bubble in the stomach with ascent, in accordance with Boyle's law.

Further x-ray studies were carried out on cats. Barium-impregnated bladders containing 50 c.c. of air were inserted into the peritoneal cavity of the animals;

decompression was carried out under a bell jar and films were made at zero, 10,000, 15,000 and 20,000 feet. During decompression, swelling of the abdomen was observed. The bladders became greatly distended as altitude increased. These experiments on cats demonstrated that expansion of gas in the abdomen is not resisted to any extent by the abdominal parietes.

The significance of the expansion of intestinal gas in the air transport of wounded men, from the point of view of peritoneal soiling, remains to be investigated. At present its seriousness at reasonable altitudes is conjectural. It may be of minor consequence compared with the soiling which occurs while the wounded are being collected from the battle field, or which would occur during jostling over a rough terrain in an ambulance, with greater delay in definitive surgical treatment. Routine precautions (enemas; insertion of rectal and stomach tubes) should be taken in all cases where indicated, particularly if the flight is to be at a high altitude.

H. H. WRIGHT, M.D.

**Pancreatic Lithiasis.** Thomas C. Jaleski. *Ann. Int. Med.* 20: 940-947, June 1944.

The outstanding symptom of pancreatic lithiasis is epigastric pain. This may be severe in nature and intermittent, or it may be mild and practically constant. Occasionally, it radiates to the back or either shoulder. Diarrhea and steatorrhea are of frequent occurrence, usually accompanying the colicky pain and vomiting. A history of chronic alcoholism is obtained in some 45 per cent of cases. Liver disease and disturbances in the carbohydrate metabolism are frequently associated. In the acute phase of pancreatitis, an increase in the serum amylase and lipase has been reported.

The two cases recorded here present different aspects of the clinical syndrome. One patient, an alcoholic, showed early disturbance in sugar metabolism, yet the pancreatic disease presented no serious threat to life. The other, who had no history of alcoholism, succumbed to progressive disease of the pancreas, but serious disturbance in the sugar metabolism developed only a few days prior to death. Roentgenograms showed the presence of stones in both cases.

STEPHEN N. TAGER, M.D.

## THE SKELETAL SYSTEM

**Epiphyseal Dysgenesis Associated with Cretinism in a Premature Infant.** Maurice L. Blatt, Mary Zeldes, and James Goodfriend. *Am. J. Dis. Child.* 67: 480-484, June 1944.

A well illustrated case of epiphyseal dysgenesis associated with cretinism is reported. The peculiar appearance of the premature infant suggested diagnoses of cretinism, chondrodystrophy, hypertelorism, and mongolism. Pertinent laboratory data included the presence of 233 mg. of cholesterol per 100 c.c. of the mother's plasma (normal 160 mg. to 200 mg.) and abnormal excretion of creatine and creatinine in the infant's urine. Roentgen studies showed multiple punctate calcified foci in all the epiphyseal centers of the long bones as well as those of the vertebrae. The patient had recurrent bouts of bronchopneumonia responding to sulfathiazole therapy, but died at three months of age. The complete autopsy report is included in the article and confirms the clinical diagnosis. The patient apparently

improved on administration of thyroxin, but succumbed to the repeated infection.

The roentgen reproductions include the entire skeleton with special views of the long bones and show good detail.

LESTER M. J. FREEDMAN, M.D.

**Osteochondritis Dissecans.** George H. Stein, R. G. Ikins, and Frederick C. Lowry. *Am. J. Surg.* 64: 328-337, June 1944.

Five cases of osteochondritis dissecans are presented and illustrated by roentgenograms; the findings are characteristic. The authors review the literature and quote Burr's description of the radiologic picture (*Canad. M. A. J.* 41: 232, 1939. *Abst. in Radiology* 35: 757, 1940).

**Importance of the Early Recognition of Congenital Dislocation of the Hip.** Vernon C. Turner. *Wisconsin M. J.* 43: 613-617, June 1944.

Early diagnosis of congenital dislocation of the hip is important in that it is curable in direct proportion to the age at which adequate treatment is begun. Studies of end-results of treatment based upon observation of patients for five to twenty years indicate that the results leave much to be desired. The percentage of cures based on anatomic and functional considerations has been under 50, though Putti reported 95 per cent functional and anatomic cures in a large series of cases from the Rizzoli Institute, in Italy. This excellent result is attributed to early recognition and treatment.

In physical diagnosis of congenital dislocation of the hip the following signs have been of most value: (1) apparent shortening of the extremity; (2) decrease in range of abduction on the affected side; (3) piston motion (on the normal side there is some excursion of the femur on push and pull, but on the dislocated side this will be much greater); (4) asymmetry of skin folds about the thigh; (5) asymmetry of the femoral head; (6) position of the trochanter near the anterior superior iliac spine. Signs of bilateral dislocation are: (1) wide perineum; (2) apparent lordosis, due to unusual fullness of the buttocks produced by posterior dislocation at the hips; (3) unusually deep skin folds of the thigh; (4) trochanters unusually near the level of the anterior superior iliac spine; (5) failure to palpate the femoral head in the acetabulum. These signs are present, however, only to the degree that there is displacement and upward riding of the femur.

The interpretation of roentgenograms may be exceedingly difficult, particularly since a large proportion of the hip is not ossified in infancy. The film should be taken with the patient flat on his back, the legs in contact, the hips extended, the patellae pointing straight upward and the tube centered directly over the symphysis pubis. The following roentgen signs are useful.

(1) The epiphysis should lie medial to a perpendicular drop from the outer lip of the acetabulum and below a horizontal line crossing the lowermost part of the ilium (Perkins' line).

(2) The acetabular roof is more sloping and the acetabular fossa shallower than normal.

(3) The epiphysis is smaller than normal and appears at a later date.

(4) The smooth curve of Shenton's line is broken.

(5) The medial margin of the proximal metaphysis lies at a greater distance from the acetabulum than it does on the normal side.

The longer treatment is delayed the greater are the pathologic changes in the capsule, the ligaments and tendons, and other soft structures about the hip, and the greater are the adaptive changes in the bones, making reduction more difficult to obtain and maintain. Aseptic necrosis of the head is more likely to occur in late reduction, and anteversion of the neck of the femur increases.

H. H. WRIGHT, M.D.

**Fractures of the Neck of the Femur: An Analysis of 157 Intracapsular and Extracapsular Fractures.** Irwin E. Siris and John D. Ryan. *Surg., Gynec. & Obst.* 78: 631-639, June 1944.

A series of fractures of the upper end of the femur is analyzed, and the advantages of immediate internal fixation are demonstrated.

**Intracapsular Fractures:** The authors believe that in the presence of an intracapsular fracture operation should be done immediately instead of waiting for the patient's condition to improve or to see if he is going to survive, as the dangers of the complications attendant upon conservative treatment outweigh those of operation. Immediate transfixion helps to preserve the blood supply to the fragments. The more proximal the fracture line the more urgent the need for immediate fixation. In the poor risk case the surgeon should be satisfied with less than perfect reduction rather than subject the patient to further manipulation. In cases of this type, fixation is recommended if there is 75 per cent reduction.

The authors use the cannulated, three-flanged Smith-Petersen nail. Local anesthesia is preferred in the aged and the depression incident to morphine premedication should be avoided. Reduction is accomplished by the Leadbetter maneuver and the extremity is then fixed on the traction table. Insertion of the guide wires is aided by a skin clip over the middle of the inguinal ligament and another 1 inch below and 1/2 inch lateral to the femoral artery.

Three sets of x-rays are considered indispensable: the first to check the reduction and locate the skin clips in relation to the femoral head, the second to locate the position of the guide pins, and the third to check the position of the flanged nail. The use of two x-ray machines which can be left in place saves time and prevents disturbing the drapes.

A burr hole is drilled 1 inch below the protruding ridge of the lower end of the greater trochanter and the edges are bevelled to prevent deflection of the guide wires by the cortex. After determining the relation of the skin clips to the head, two guide wires are inserted. The operator should be able to push them without drilling until they strike the head. In high subcapital fractures the guide wire is drilled for a short distance into the acetabulum to prevent rotation when the nail is inserted. The second set of roentgenograms is then taken and the better of the two guide wires is used for the insertion of the nail.

A light plaster boot to the knee with a horizontal board behind the heel is applied to insure against outward rotation. Turning of the patient on the uninjured side should be prohibited, as this predisposes to disengagement of the nail. The patient is allowed out of bed in a week.

**Extracapsular (Intertrochanteric) Fractures:** Extracapsular fractures made up 64 per cent of the authors' series of 100 cases. This type is more serious because of greater shock and more rotation, deformity,

and soft-tissue damage. It also carries a higher mortality (22 per cent) than the intracapsular variety (8.7 per cent).

Bilateral Russell traction is the simplest form of treatment if the patient can stand the prolonged stay in bed. Transfixion presents difficulties, because there is usually comminution and the grip on the distal fragment is inadequate. Neither Moore pins nor the Smith-Petersen nail alone will give a satisfactory result. A combination of a Hawley bar and a Smith-Petersen nail proved fairly satisfactory, but the blade plate designed by Moore and Blount is the treatment of choice.

The authors' experiences definitely indicate that external pin fixation is unsatisfactory and hazardous. The operation itself presented no difficulties and the patients showed practically no shock or reaction to the procedure. However, the friction of the soft tissues against the pins caused discomfort and increased the nursing care needed. Seepage and infection complicated the cases, and the mortality was high.

J. L. BOYER, M.D.

**An Analysis of Colles's Fracture.** S. C. Rogers. *Brit. M. J.* 1: 807-809, June 17, 1944.

In introducing his subject the author points out that there is a very wide variation in so-called Colles's fractures and that, furthermore, there is a notable lack of description of these variations in most standard texts on the subject. After a short description of the anatomy of the human wrist, a series of 219 fracture cases is classified as follows: (A) simple fractures, 59 cases; (B) fractures with an oblique posteromedial fragment, 108 cases; (C) comminuted Colles's fractures, 35 cases; (D) with vertical fracture of the radial styloid, 11 cases; (E) with transverse fracture of the base of the radial styloid, 2 cases. Treatment consists in disimpaction by strong traction, application of plaster, and graduated exercises.

Q. B. CORAY, M.D.

## OBSTETRICS AND GYNECOLOGY

**Radiological Pelvimetry. A New Zealand Study.** E. Peter Allen. *New Zealand M. J.* 43: 116-129, June 1944.

The author presents the internal pelvic measurements of a series of 220 New Zealand women referred to the New Plymouth Hospital for radiological examination. He believes these figures to be fairly representative of New Zealand-born women as a whole and compares them to series reported by Nicholson (*J. Obst. & Gynaec. Brit. Emp.* 45: 950, 1938), representing "a fair sample of the women of child-bearing age in Gloucestershire and probably in rural England," and by Ince and Young (*J. Obst. & Gynaec. Brit. Emp.* 47: 130, 1940) considered "a fair sample of London women of British parentage." A statistical approach is utilized, and the magnitude and source of error are indicated.

The author finds substantial agreement between the British authors, standard textbooks, and himself, in regarding the mean value of the transverse diameter of the inlet to be in the region of 133 mm. However, the mean value of the New Zealand obstetrical conjugate is significantly higher than that recently reported from England, both in rural and urban groups, and grossly larger than any textbook estimate. Since the racial background of the British group is compar-

able, Allen agrees with the suggestion of Thoms that adequate nutrition has more influence on pelvic shape than is generally thought, and further states that the shape of the pelvis is determined more by environment and diet than by inherited racial tendencies.

In the group of cases reported, labor was conducted by different doctors, and different indications for rendering active assistance obtained. There was, therefore, only slight correlation between measurements and the clinical course of labor.

ELLWOOD W. GODFREY, M.D.

## GENITO-URINARY TRACT

**Supernumerary Kidney with Clear Cell Carcinoma.** Mark Exley and W. S. Hotchkiss. *J. Urol.* 51: 569-578, June 1944.

The forty-sixth supernumerary kidney of the world's literature is here reported. The authors believe it the first authentic example containing a malignant growth.

The preoperative diagnosis of supernumerary kidney has been made only three times, and many cases have been discovered only at autopsy. Intravenous urography is not reliable, since the function of the kidney may be reduced or nil. Retrograde pyelography is usually needed, as in the present case. Symptoms are due to the disease affecting the extra kidney.

The age span of the reported cases is from nine months to sixty-seven years. Most of the symptoms have appeared in the second decade. The sexes are equally afflicted.

The abnormal kidney may be almost anywhere, but is usually below the normal organ. Several have been found in the true pelvis. The majority of ureters fuse before reaching the bladder. If this is not the case, a diligent search must often be made to locate the third ureteral orifice, which may be found in bizarre locations outside the bladder.

Infection and calculus are the most frequent lesions. One case of malignant neoplasm has been previously recorded, but this is regarded as questionable.

The case reported by the present authors occurred in a 65-year-old man, who showed no metastases and recovered completely following nephrectomy.

EDWIN L. LAME, M.D.

**Primary Epithelioma of the Ureter: Follow-Up Study of 18 Cases with the Addition of 9 New Cases.** Virgil S. Counseller, Edward N. Cook, and Philip H. Seefeld. *J. Urol.* 51: 606-615, June 1944.

The extent of the surgery performed and the inherent pathological grade of the tumor tissue are the two factors influencing the end-result in primary epithelioma of the ureter. This paper is a follow-up report of 18 cases, with consideration of the influence of these two factors in the results obtained.

Primary carcinoma of the ureter appears in the sixth and seventh decades of life, usually in the lower portion of the ureter, the majority of the patients being men. The outstanding symptoms are hematuria and pain, varying from a dull ache to renal colic. A mass is sometimes palpable. Diagnosis is made, or at least strongly suggested, by intravenous urography and retrograde pyelography. Occasionally the tumor can be seen peeping from the ureteral orifice on cystoscopy.

The treatment of choice is complete nephro-ureter-

ectomy with removal of all the periureteral adipose tissue plus resection of the uretero-vesical section of the bladder. The authors emphasize the need for long cystoscopic follow-up, as tumors of the bladder may follow extirpation of the ureteral neoplasm with no apparent relationship.

These neoplasms are squamous-cell epitheliomas with a tendency toward papillary structure. The authors use the classification of Broder, grading them on to four with ascending malignancy. The grade is undoubtedly the main factor influencing the prognosis. Patients with tumors of the lower grades have done well under radical surgical treatment. Tumors of the higher grades, however, less frequent than those of the lower grades, have not responded well to any form of treatment. Seven of 10 patients with epithelioma of grades 1 and 2 are alive and well for periods ranging from four to thirteen years. Seven of eight patients with growths of grades 3 and 4 were dead within a two and one-half year span.

J. FRANCIS MAHONEY, M.D.

**Thrombosis of the Renal Vein.** William F. Melick and Alvin E. Vitt. *J. Urol.* 51: 587-596, June 1944.

In children, renal vein thrombosis is almost always secondary to severe ileocolitis or gastro-intestinal upsets. In adults, such thrombosis is usually due to inflammation of the renal pedicle from perirenal suppurations, renal abscesses which have ruptured into the perinephrium, or secondary to a pyelonephritis. The thrombosis may also be secondary to an ascending venous thrombosis originating in either the veins of the pelvis or lower extremities.

The onset is usually sudden: there is fever, with pain and tenderness on the affected side. The kidney is enlarged, movable, and tender. Usually there are signs of infection and severe toxicity. Hematuria is present in almost every case. A history of previous colitis or thrombophlebitis is a common feature.

The author describes a case in which a retrograde pyelogram was secured a short time after the onset of the thrombosis, the first time a retrograde pyelogram has been normally made in such a case. The involved pelvis was poorly visualized, irregularly filled, and somewhat irregular in outline. Intravenous pyelography, which was used chiefly in the earlier reported cases could show only one thing, namely, lack of function. Retrograde pyelograms, if not obtained shortly after the onset of the thrombosis, will show complete failure of filling of the renal pelvis.

Immediate surgical removal seems to be the treatment of choice. Heparin or dicoumarin are recommended to prevent possible further extension of the thrombus formation.

DAVID KIRSH, M.D.

## LEGAL ASPECTS OF RADIOLOGY

**Radiology and the Law.** S. W. Donaldson. *Ohio State M. J.* 40: 517-520, June 1944.

The standard of the medical specialist is determined by physicians devoting special attention and study to the same branch in similar localities. The specialist is bound to keep abreast of the times, but may not go beyond the accepted methods of modern practice unless he is prepared to take the risk of establishing by his success the propriety and safety of his experiment.

Most malpractice suits are based on negligence and allege that the physician failed to comply with his implied contract or with one set up by statutory law. For example, the allegation may be a want of professional skill or knowledge. Negligence of a physician or surgeon cannot be inferred from a poor result alone. There must be evidence from expert witnesses to show improper and unskillful treatment in order to sustain a charge of malpractice. A physician may also be sued for malpractice because of the acts of his assistants or employees. A radiologist does not enjoy immunity if he is connected with a charitable institution.

A roentgenogram to be admitted as evidence must

be verified, and the court must be satisfied that it represents a person or thing material to the case. Some jurists recognize the fact that the introduction of the film in itself means little, but its interpretation by an expert who has had years of training and experience in reading similar films is the important thing to consider.

The author advises that an appearance in court may be facilitated by (1) a familiarity with court-room procedure, (2) a thorough knowledge of the case history and all findings, (3) simple answers without volunteering testimony, and (4) adherence to the absolute truth.

ELLWOOD W. GODFREY, M.D.

## RADIOTHERAPY

### NEOPLASMS

Cancer of the Lip. S. J. Douglas. *Brit. J. Radiol.* 17: 185-189, June 1944.

During 1939, 71 cases of cancer of the lip were treated; 46 by contact therapy. All but one of the patients were males, chiefly outdoor laborers. The average age was 62, the youngest patient being 32 and the oldest 81. In every case the lesion was on the lower lip. Important factors in the etiology are oral sepsis and the presence of sharp tooth stumps, pipe smoking, and exposure to wind and sun. Most of the cancers develop on a leukoplakic or keratotic base. Fair skinned persons are particularly susceptible.

The average duration before treatment was started in the series reported was eight months. Ten cases were in Stage I (lesion less than 1.5 cm. in diameter); 44 cases in Stage II (greater than 1.5 cm. in diameter but not attached to surrounding structures); 17 cases in Stage III (invading or attached to surrounding structures). Seven patients had been treated by "cancer cures" with arsenic paste. Twenty-eight per cent had palpable lymph nodes when first seen. These disappeared in 9 cases following treatment of the primary lesion and correction of oral sepsis. In 7 cases palpable nodes appeared following treatment.

Cancer of the lip is nearly always squamous-cell in type. The diagnosis is usually easy. Tuberculosis of the lip and chancre may resemble cancer but usually show less induration. In chancre there is usually bilateral enlargement of the lymph nodes, with a short history. Other rare conditions which may resemble cancer are hemangioma and aberrant salivary gland tumors.

Dental sepsis is first treated. It is often necessary to remove several teeth. Tumors thought to be too indurated or too large for x-ray therapy are treated with radium implantation, 7,000 r being given in about seven days. Of 16 patients thus treated, 6 were alive and well one year later.

Of the 46 patients receiving contact x-ray therapy, 14 had palpable nodes when first seen and in 5 these developed during treatment. Eight had Stage I tumors, 33 Stage II, and 5 Stage III. Thirty-seven were alive and well three years following treatment, but these are not classified according to stages. In one case a second epithelioma developed on the upper lip two years after treatment. The treatment factors were 60 kv., 4 ma., and focal skin distances of 3, 5 or 7 cm. A total surface dose of 8,000 r is given in

10 daily doses of 800 r each, treatment being omitted on Saturdays and Sundays. If the tumors are bulky, two opposing fields are used and, if large, two adjacent areas.

With small primary lesions and no palpable nodes in the neck, prophylactic surgery or irradiation to the neck is contraindicated. When small mobile nodes are present, a block dissection should be done as soon as possible. It is usually advisable to excise the primary lesion also. If the metastatic nodes are fixed, the choice of treatment lies between interstitial radium and high-voltage x-rays. With a single fixed node, implantation will usually be successful; otherwise high-voltage x-rays give better palliation. Eighteen of 34 patients showing adenopathy (53 per cent) were well and free from disease at the time of the report.

SYDNEY J. HAWLEY, M.D.

X-Ray Therapy of the Heart in a Patient with Leukemia, Heart Block, and Hypertension. Report of a Case. H. Blotner and M. C. Sosman. *New England J. Med.* 230: 793-796, June 29, 1944.

A 64-year-old female with long-standing hypertension had a myelogenous leukemia that responded well to spray irradiation for two years. A 2:1 heart block then developed, believed to be due to leukemic infiltration of the bundle of His. Irradiation was applied directly to the cardiac region giving five times 200 r from Aug. 11 to 25, with 200 kv., 50 cm. distance, and 0.5 mm. copper filtration. The block was relieved. The treatment was repeated in November and December because of recurrence of the block. Later, spray radiation was given because of elevation of the blood count, but this had no definite effect on the heart block. The patient died the following May with a right hemiplegia. JOHN B. McANENY, M.D.

Case of Acute Leukemia Complicating Pregnancy, with Necropsy Findings in the Fetus. H. S. Applebaum. *Ohio State M. J.* 40: 536-537, June 1944.

A case of acute myeloid leukemia developing in the first half of pregnancy is reported, with postmortem findings in the fetus. The onset of the illness occurred during the third month of pregnancy, and the course was progressively downhill. A Cesarean section was performed at about eight and a half months in the hope of saving the child and perhaps rendering some relief to the mother. The fetus was found dead and the mother expired several hours later.

## ABSTRACTS OF CURRENT LITERATURE

February 1945

ing seen in watch dial painters. The outstanding difference lies in the uniform finding of hypoplastic bone marrow in the rats, whereas many of the dial painters had a hyperplastic, regenerative marrow. This difference may be due to the fact that the amount of radium retained by the rats was much greater in proportion to body weight than in the dial painters. A useful bibliography is appended.

**Concentration of Red Blood Corpuscles Containing Labeled Phosphorus Compounds in the Arterial Blood after the Intravenous Injection. Preliminary Report.** Gustav Nylin and Mignon Malm. *Am. J. M. Sc.* 207: 743-749, June 1944.

A prolonged circulation time in heart disease means a slow circulation and is a criterion of decompensation. There are, however, many patients without signs of congestion or decompensation, with normal venous pressures, but with dilatation of the heart and a pathologically great heart volume in which the circulation time is markedly prolonged. Duration of the taste sensation of decholin is also prolonged in these cases.

In order to determine the role of the residual heart blood in prolonging the circulation time, the velocity of blood flow was studied by labeling the patient's blood with radioactive phosphorus. A small amount of the labeled blood was re-injected intravenously. At the same time, samples of arterial blood were taken at intervals of several seconds from the opposite arm. The amount of activity of the corpuscles of each sample was measured with a Geiger counter.

In a normal subject, the labeled corpuscles appeared in the arterial blood in about thirteen seconds, reaching a peak at nineteen seconds after injection, and falling rapidly to a minimum at thirty-three seconds. A new lower peak appeared at about thirty-five to forty-three seconds, probably as a result of recirculation. There

was a strong correlation with the decholin taste test, which appeared at fifteen seconds and persisted to thirty-four seconds.

In a patient with severe cardiac dilatation due to mitral stenosis, the labeled corpuscles reached a peak at twenty-five seconds. During the period from thirty to sixty-five seconds there were small irregular peaks in the curve. The decholin taste test appeared at twenty seconds and persisted to ninety seconds. In the normal there is a good correlation between the velocity of blood flow as determined with corpuscles labeled with radioactive phosphorus and as determined by the decholin taste test. In cardiac dilatation without congestion there is evidence to suggest that the residual blood in the heart plays a part in the prolongation of the circulation time.

BENJAMIN COPELMAN, M.D.

**On the Maximal Energy Attainable in a Betatron** (Letter to the Editor). D. Iwanenko and I. Pomeranchuk. *Physical Rev.* 65: 343, June 1 and 15, 1944. The authors writing from the Physical Institute of the Moscow State University, U.S.S.R., give calculations as to the maximal energy attainable in a betatron. They observe that the rotating electrons in the magnetic field must necessarily radiate energy. Therefore, they cannot be accelerated past the place where they are radiating energy as fast as the changing magnetic field is delivering energy to them. Taking the value for the magnetic field now in use, in present models of betatrons, they arrive at a limiting value of five hundred million electron volts, which is only five times as great as the energy which one expects to obtain from the betatron now under construction (at the University of Illinois). A higher value could be attained by reducing the magnetic field and increasing the frequency.

R. R. NEWELL, M.D.

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# RADIOLOGY

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## Carcinoma of the Cheek, Alveolar Processes, Floor of the Mouth, and Palate<sup>1</sup>

RICHARD H. BEISWANGER, M.D., and K. WILHELM STENSTROM, Ph.D.

Minneapolis, Minn.

STATISTICAL studies indicate that 7 per cent of all fatal cancers in man originate in the oral region (1). With the present facilities for diagnosis and treatment, it seems that this figure should be appreciably reduced. These neoplasms are readily detected and, when seen early enough, are not too difficult to cure. Yet, as will be shown later, most of the patients when first seen present lesions which have extended beyond their original confines. As a result, the five-year cure rate remains discouragingly low, despite definite advances in therapy. For an extensive review of the history of this subject, the reader is referred to Albright's article, published in 1935 (2).

The present study includes carcinoma of the cheek, alveolar processes, floor of the mouth, and hard and soft palates. During the years 1926 to 1940, inclusive, 160 cases of carcinoma arising at these sites were referred to the Section of Radiation Therapy, University of Minnesota Hospitals, for treatment. All were followed in the Out-Patient Clinic, and when a patient failed to return to the Clinic, letters were sent to the family physician or relatives. Only one case remained untraced.

In 129 of the 160 cases the diagnosis was established by biopsy. The remaining 31

patients either had no biopsy or, if biopsy was done, the report was unavailable. The two groups will be considered separately in discussing the results of treatment.

### CLASSIFICATION

The cases in this series are divided into six sub-groups according to the location of the growth, as follows: carcinoma of the upper alveolar process, 21 cases; of the lower alveolar process, 34 cases; of the cheek, 58 cases; of the floor of the mouth, 27 cases; of the hard palate, 12 cases; of the soft palate, 8 cases.

The lesions have also been grouped clinically, according to their extent, as follows:

Stage I. Under 1.5 cm. in diameter . . .	2 cases (1%)
Stage II. Over 1.5 cm. in diameter with no local extension . . . . .	34 cases (21%)
Stage III. With local extension . . . . .	54 cases (34%)
Stage IV. With metastases on admission . . . . .	70 cases (43%)

Howes and Bernstein (3), using a somewhat similar classification, report 9 per cent of 138 cases as of Stage I, 33 per cent Stage II, 9 per cent Stage III, and 57 per cent Stage IV. It will be noticed that in 43 per cent of our series metastases were present on admission, and in 77 per cent the disease had extended beyond its original confines either by local extension or metastasis or both.

<sup>1</sup> From the Department of Radiology and Physical Therapy of the University of Minnesota and the University Hospitals, Minneapolis, Minn. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

TABLE I: ETIOLOGIC FACTORS IN ORAL CARCINOMA

Site	Total No. of Cases	Use of Strong Tobacco	Leukoplakia	Ill-fitting Dentures	Sharp Teeth
Alveolar processes	55	11 (20%)	10 (18%)	12 (21%)	2 (4%)
Cheek	58	15 (26%)*	16 (27%)	4 (7%)	6 (10%)
Floor of mouth	27	7 (26%)†	4 (15%)	6 (22%)	0
Palate	20	2 (10%)	3 (15%)	2 (10%)	0

\* 13 of 15 chewed tobacco. † 4 of 7 chewed tobacco or used snuff.

### ETIOLOGY

Cancer of the oral cavity is predominantly a disease of old age. The average age in our series was 65 years, the age range being from 36 to 88 years. Two patients were between 30 and 39; 8 between 40 and 49; 35 between 50 and 59; 51 between 60 and 69; 47 between 70 and 79; 12 over 80. In 5 the age was undetermined. Martin and Pflueger (4) report an average age of 59 in 99 cases of cancer of the cheek seen in the Memorial Hospital, New York. The average age for all intra-oral cancer in that hospital is given by Martin and Sugarbaker (5) as 57 years.

Of our patients, 19 (12 per cent) were females and 141 males (88 per cent).

Chronic irritation is an obvious etiologic factor. The most common irritants are sepsis, dental appliances, syphilis, and the stronger forms of tobacco, such as are present in chewing tobacco, snuff, pipe tobacco, and cigars. Lund (6), discussing the cause and prevention of buccal cancer writes: "Normally the mucous membrane of the mouth is comparatively resistant to the development of cancer as shown by the fact that women, who very largely do not chew tobacco or smoke pipes and whose mouths average much cleaner, in other ways than men's, have buccal cancer but one-eighth as frequently as men." Davis (7) attributed the prevalence of carcinoma of the cheek in the Philippine Islands to the chewing of *buyo*, which is a combination of buyo leaf, betel nut, slaked lime, and tobacco. This habit is more common among women than men and the incidence of carcinoma of the cheek in the Philippines is higher among women.

Quick (8), discussing leukoplakia and

allied mouth conditions, states that "local sepsis of chronic character is also under-rated in its probable relation to cancer. Tissue specimens from chronically infected gum margins show all the changes from simple hypertrophy to beginning downgrowth of the basal layer in an irregular papillary manner and ultimately to fully developed cancer."

Figi (9) states that carcinoma of the mouth often develops adjacent to carious teeth and ill-fitting dentures. On the other hand, such growths are encountered infrequently in edentulous persons and, when they do occur, are almost always of an inactive type. He considers the role of tobacco still debatable.

Fraser (10) of Edinburgh, writing in *Annals of Surgery*, states the case as to sepsis quite clearly: "Mouth infection is the most constant and prevailing associated influence, and we have no doubt that it plays a highly significant part in the production of the malignant error. An analysis shows that at least 50 per cent of the cases were infected with pyorrhea alveolaris prior to the development of the cancer, and from what we have seen, we are satisfied that this influence is one of the most significant in the etiological picture, that it is the most common and constant factor, and that its influence is increased when it is combined with other irritant factors such as alcohol, tobacco, syphilis or direct local irritation."

Table I lists the possible causes of cancer in this series. Dental sepsis was present in 95 per cent. Among tobacco users we have included only those using the stronger forms for a long period of time. Ill-fitting dentures have been considered as a factor only when irritation from this cause ex-

tended over a long period, ten to twenty years in most cases, never under five years. In this connection, it is interesting to note that in 6 of the 19 females of the series, *i.e.*, 31 per cent, an ill-fitting dental plate was considered to be the causative factor. In 69 cases no possible cause was recorded other than sepsis. Information was lacking in some of the charts, and it is probable that the tobacco habit played a greater role than the figures indicate. The incidence of syphilis was low—8 cases or 5 per cent. Syphilis is a more important factor in cancer of the tongue. Associated intra-oral leukoplakia occurs most commonly on the cheek, 27 per cent in this series. Its incidence closely parallels the use of strong tobacco. Martin and Pflueger (4) report leukoplakia present in 22 per cent of carcinomas of the cheek.

#### HISTOLOGY

The tumors, except for two adenocarcinomas of the hard palate, were all of squamous-cell origin.

#### SYMPTOMS

The average duration of symptoms before the institution of treatment was 8.6 months. Carcinoma of the oral cavity, like all carcinoma, is symptomless in the earliest stages. One-half the patients complained of pain as the first symptom, which indicates that the lesion had been present for some time; the other half complained of an ulcer, local swelling, or enlarged cervical lymph nodes.

The more malignant lesions first appear as small indurated ulcers or fissures in the mucosa. As the lesion penetrates, pain increases and finally becomes continuous. The more benign lesions usually appear as a papillary mass, often developing on an area of leukoplakia. Their growth is slow and there is not the early tendency to invasion or spread by cervical metastasis shown by the ulcerative lesion.

In time, the lesions grow deeper and become necrotic. Those involving the cheek are stretched and those elsewhere in the mouth are irritated by the ingestion of food

and the movements of mastication. The cheek may be perforated, and lesions invading the pterygoid or temporal muscles will cause trismus. Carcinomas of the floor of the mouth remain infected because of poor drainage. Infection is followed by pain and swelling. Hemorrhage by erosion of an artery may occur. Death results from several causes—infection, hemorrhage, malnutrition.

#### DIFFERENTIAL DIAGNOSIS

The differential diagnosis is not too difficult. A biopsy should be done in every case. Other diseases which may form ulcers on the intra-oral mucosa are syphilis, tuberculosis, superficially ulcerated or fissured leukoplakia, herpes, and simple granulomas (as that caused by trauma), Vincent's angina, etc. Only after repeated negative biopsies for carcinoma may some syphilitic lesions be differentiated. Then, if the Wassermann reaction is positive and the lesion responds to two or three weeks of intensive antisyphilitic treatment, carcinoma may be ruled out. The two diseases commonly co-exist.

The base of the ulcer in tuberculosis is yellowish, as compared to the coarse beefy appearance of the cancerous lesion. A tuberculous ulcer occurs most commonly on the tongue. In this case, biopsy fails to reveal cancer and tuberculosis can almost always be found elsewhere.

Fissured leukoplakia may be diagnosed by biopsy and treated by cautery or radiation. It is advisable to do a biopsy on any ulcer that persists for more than two weeks.

#### METASTASES

Of 146 patients, 104 (70 per cent) had palpable nodes on admission; in 14 the presence or absence of palpable nodes was not recorded. In 73 (70 per cent) of the 104 cases, the nodes were proved to be metastatic, either by the subsequent clinical course or microscopically. Table II gives the number of cases with metastases at the time of admission, grouped according to site.

TABLE II: PRESENCE OF METASTASES IN ORAL CARCINOMA

Location of Primary Lesion	No. of Cases	Cases with Metastases on Admission	Percentage of Metastases	Cases with Metastases Developing after Admission
Upper alveolus	18	7	40%	1
Lower alveolus	23	8	35%	0
Cheek	49	27	55%	4
Floor of mouth	21	9	43%	2
Hard palate	10	3	30%	2
Soft palate	8	5	73%	0

TREATMENT

It is well to decide whether treatment is to be an attempt at cure or merely palliative. There are three distinct problems: (1) hygienic care of the oral cavity before, during and after treatment; (2) treatment of the primary lesion; (3) management of cervical metastases.

*General Hygienic Measures:* In the type of patients we receive for treatment, the mouth is generally in poor condition. All broken, jagged, infected teeth, as well as all teeth in the proposed field of irradiation, should be immediately extracted. Daily mouth washes or saline irrigations are advised, and the patient should learn how to use a toothbrush. Necessary vitamin therapy should be prescribed, and the use of tobacco discouraged.

*Treatment of the Primary Lesion:* Treatment of the primary lesion is by surgery with subsequent irradiation, irradiation with subsequent surgery, or irradiation alone. In some of our cases the surgical bed was immediately implanted with 0.3 mm. gold-filtered radon implants. Others were referred for radiation therapy by the surgeon because the entire lesion could not be excised or because of recurrence. In recent years most cases have been referred directly from the tumor clinic for irradiation.

Since the period covered by this review extends from 1926 to 1940, these patients have been treated in various ways. Radon has been used extensively, however, in almost all the cases, including the early ones.

Treatment now usually consists in the local application of radium molds (primary lesion) and external irradiation (x-rays) over a period of twenty-one to twenty-eight days. Gold radon implants are then inserted into soft-tissue lesions and around metastatic nodes. If any persistence is noticed two months later, a radical dissection is advised in operable cases. The factors for external irradiation are: 220 kv., 15 ma., usually 60 cm. target-skin distance, with 0.5 to 1.0 mm. Cu plus 1.0 mm. Al filter. Multiple fields are treated, usually three, sometimes four, 200 to 300 r in air being given to one field daily until a definite dermatitis is produced on the skin. By these methods approximately 3,000 (x-ray) r and 4,000-7,000 (gamma) r are delivered to the lesion. Martin, Quimby and Pack (11) have shown that it takes 7,000 to 10,000 gamma-ray roentgens delivered in ten to twenty days to destroy epidermoid cancer.

The treatment of the cervical nodes, as well as special treatment to the different sites, will be discussed more fully below.

Different clinics favor different methods of getting the lethal dose to the center of the tumor. Regaud (12) prefers to use intratumoral radium needles, arguing that these provide a more constant source of radiation. Berven (13) of the Radiumhemmet (Stockholm) uses teleradium with subsequent electrocoagulation, or surface application of radium to the primary tumor and as a preliminary to dissection of the cervical nodes if these are involved. Grier (14) objects to radium needles, as likely to introduce infection. He uses them only in the tongue and tonsils, and then for only a short period.

*Treatment of Cervical Metastases:* There is a considerable difference in the incidence of metastases from the various regions of the oral cavity. According to Nathanson and Taylor (15), the mobility of the part appears to be a factor in the production of cervical metastases. Thus there is a higher incidence of metastases from the mobile tongue, floor of the mouth, and soft palate than from the comparatively rigid hard

palate and gingivae. It is possible that the continuous massaging of the primary cancer in these areas favors dissemination. The incidence of metastatic spread is less from the anterior third of the cheek than from that part which overlies the masseter muscle, where the lesion is continuously massaged by the movements of mastication.

The stage of the disease as well as the extent of the growth influences the occurrence of metastases. If all cases were left untreated, all would no doubt ultimately metastasize. When the carcinoma spreads to neighboring structures, it may be spreading not only to a part of the oral cavity from which metastases are more likely to occur, but it also gains access to a greater number of lymphatic channels. The grade of malignancy of the lesion, as well as the type of growth, ulcerative and invasive or papillary, is of course an extremely important factor in the incidence of metastasis.

Distant metastases are rare in oral cancer, the disease rarely extending below the clavicles. Usually relatively few nodes are involved unless the tumor has reached an inoperable stage. Bilateral metastases, however, are not uncommon.

Dissection of involved cervical nodes is indicated, according to Duffy (16), only if the primary lesion is controlled; if it is limited to one side of the oral cavity and is of highly differentiated cell type; if the metastases are limited to a single group of nodes or to nodes in two contiguous cervical triangles; if the capsule of the node is not infiltrated by carcinoma; if the opposite side of the neck is free of metastases and no distant metastases are present, and if the patient is in good general condition.

Control of the primary lesion is the first requisite in treatment, since its recurrence will surely result in recurrence of metastases, either on the same or opposite side of the neck. If no metastases are present, control of the primary tumor will prevent their subsequent development and prophylactic neck dissection will not be necessary.

TABLE III: RESULTS OF TREATMENT IN CASES WITH CERVICAL METASTASES

Site	No. of Cases	5-year Cures	Treatment
Upper alveolar process	6	2	Radiation and surgery
Lower alveolar process	5	0	
Cheek	21	1*	Radiation
Floor of mouth	6	0	
Hard palate	2	0	
Soft palate	3	0	
Total	43	3 (7%)	

\* Clinical.

Lesions which extend to or beyond the mid-line are usually large and of a high degree of malignancy and therefore hard to control. Small lesions, however, may extend across the mid-line, and such extension should not of itself contraindicate neck dissection. Neither should a high grade of malignancy alone necessarily exclude dissection. If the cancer is highly malignant, however, there are usually other contraindications as well.

In general, we agree with Duffy that dissection is not indicated unless metastases are actually present. Some patients, however, harbor metastases which cannot be diagnosed clinically. Others have cervical nodes which appear to be involved but at operation are found to be merely hyperplastic. The percentage of error in this respect, as given by Duffy (16), varies from 15 to 35 per cent, *i.e.*, one-sixth to one-third of nodes showing signs suggestive of cancer are found to be hyperplastic. If all are subjected to neck dissection, many unnecessary operations will be done and there will be some postoperative deaths. This disadvantage must be weighed against the fact that some with actual but not clinically evident involvement will have the benefit of early neck dissection.

We have not advised prophylactic neck dissection but have followed our cases very closely, once every four weeks for six months, and every two months thereafter for two years.

Table III gives the results of treatment in cases with cervical metastases. These cases were treated with external irradiation, radon implantation, and block dis-

section of cervical nodes when indicated. Far-advanced cases were given palliative treatment only. Almost all patients, whether with or without cervical metastases, received some irradiation to the cervical region at the time the primary lesion was treated. If metastases were thought to be absent, the dose to the neck was somewhat less than that given to the primary lesion. If metastases were thought to be present, block dissection was done where not contraindicated. If block dissection was contraindicated and treatment was not purely palliative, external irradiation was given to the cervical region to the limit of skin tolerance and radon seeds were then implanted around the involved node or nodes for a total dosage of 7,000 to 10,000 gamma ray and x-ray roentgens. Palliation of varying degree and duration was obtained in practically all cases.

*Treatment of Cervical Metastases at Other Clinics:* Hayes Martin (17) believes that one or two erythema doses to each side of the neck are probably of no value. He uses fractionated roentgen irradiation, including only the node and a surrounding area of 1.5 cm. He gives 4,000 to 8,000 r in two or three weeks, then 5 to 10 T.E.D. by radon. He believes radiation treatment of the entire lymph-bearing area to be dangerous and holds that better results will be obtained by treating each node separately. For small nodes radon seeds are sometimes enough. Some authors have stated that there are no authentic cures of cervical metastases by radiation. Martin (17) reports 46 five-year cures in cases where the presence of metastases was proved by aspiration biopsy.

Albright (2) refers to Mekie's series (1932) of 268 collected cases of mouth cancer with metastases to the cervical nodes (his own cases and those of Forssell and Quick); only 8 (3 per cent) were cured. Albright also cites Simmons' experience. This latter writer, in 376 cases of mouth cancer, reported 5 per cent surgical cures in patients with clinical metastases and none by radiation (admittedly inadequate in dosage). Forssell, also quoted by Albright,

reported 72 cases with neck metastases with no cures by radiation. Judd and New (18) in 1927 reported 5 per cent surgical cures in carcinoma of the oral cavity with lymph node metastases.

#### COMPLICATIONS

*Hemorrhage* may occur because of erosion of the facial or external maxillary artery. Ligation of the external carotid artery on the affected side may be necessary.

Healing may be delayed because of *local necrosis* of soft tissue. Such local necrosis is more apt to occur if the facial artery is severed during a neck dissection.

When extensive radiation is applied to bone, *radiation necrosis* may result. It is thought that this is due to interference with the circulation. This subject is adequately covered in a fairly recent article by Watson and Scarborough (19). According to their report, this complication developed in 48 (40 per cent) of 121 patients with carcinoma of the alveolar ridge treated at Memorial Hospital, in 62 (34 per cent) of 180 with tumors in the floor of the mouth, and in 37 (25 per cent) of 149 with carcinoma of the cheek. They believe that the present protracted method of irradiation is less damaging.

In our series of 160 cases treated, 14 (9 per cent) suffered from osteoradionecrosis. The highest incidence (14 per cent) followed treatment to lesions of the lower alveolar process. The average time which elapsed between the beginning of treatment and the development of necrosis of bone was eight months. The longest interval was two years.

Treatment is conservative. The patient may have to be fed with a nasal catheter because of painful swallowing, trismus, or salivary fistula. Frequent mouth irrigations are recommended. It may be necessary to inject the involved sensory nerves with alcohol. Sequestra are removed when possible. After sequestration and removal of bone splinters, pain usually disappears promptly. Resection of the mandible is dangerous if attempted late, as evidenced



TABLE IV: RESULTS OF TREATMENT IN CARCINOMA OF THE ALVEOLAR PROCESSES, CHEEK, FLOOR OF MOUTH, HARD AND SOFT PALATES—ALL CASES

Year	No. of Cases	Years of Survival														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1926	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1
1927	7	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1928	4	4	1	1	1	1	1	1	1	1	1	0	0	0	0	
1929	9	7	2	1	1	1	0	0	0	0	0	0	0			
1930	2	1	1	1	1	1	1	0	0	0	0	0				
1931	9	3	2	2	2	2	1	1	1	1	1					
1932	16	14	10	7	7	7	7	5	5	3						
1933	19	9	7	6	5	5	4	3	3							
1934	7	4	2	2	1	1	1	1								
1935	13	7	4	0	0	0	0									
1936	9	7	3	3	3	3										
1937	13	11	10	8	3											
1938	12	8	6	4												
1939	13	10	6													
1940	24	14														
Cases	160	160	136	123	111	98	89	76	69	50	34	25	23	14	10	3
Survival		103	58	39	28	24	16	12	11	6	3	1	1	1	1	1
Per cent		64	42	32	25	24	18	16	16	12	10	4				
Lost		1 (Considered no survival)														

by the report by Watson and Scarborough (19) of 22 per cent mortality in their series of 51 cases.

The incidence of radiation necrosis can be materially reduced by the adoption of a few preventive measures. The mouth must be kept clean. Loose or carious teeth should be extracted before radiation therapy, and devitalized or decalcified teeth may be extracted or ground down to the alveolar margin and root canals filled. Some go so far as to extract all teeth, sound or unsound, in the proposed field of irradiation. Portals should be selected which will avoid bone as much as possible.

When radium is used, the uninvolved parts can be partially protected by incorporating lead in the mold. Resection of that part of the bone most prone to develop this complication shortly after completion of therapy is advocated by some.

#### RESULTS OF TREATMENT

Table IV gives the results in all cases referred to the department for treatment, while Table V gives the results of treatment in cases proved by biopsy. Both tables show the same five-year survival rate, 24 per cent, indicating that clinical judgment as to the presence of a malignant process,

in the absence of a biopsy, was accurate. For the results of treatment at the different sites, only those cases with a positive biopsy will be included. The five-year survival (free of disease) for patients without metastasis was 15 out of 33, or 45 per cent.

*Carcinoma of Upper Alveolar Process (Positive Biopsy):* There were 18 cases of carcinoma of the upper alveolar process with positive biopsy. Among 15 cases treated up to and including 1936 there were 7 (47 per cent) five-year survivals. Six of the 15 patients had metastases at the time of admission. Two of the 6 with metastases are among those surviving five years. In the other 4 with metastases, the disease was not controlled. Nine of those treated up to and including 1936 had no metastases on admission. In one of these metastases developed and death occurred after two years with disease. Five of the 9 survived five years or longer.

Most of these lesions are extensive when first seen and are therefore best treated by a combination of radiation and some form of surgical diathermy. Some may be controlled by radiation alone.

Treatment by radiation consisted of external irradiation supplemented by radon

TABLE V: RESULTS OF TREATMENT IN CARCINOMA OF THE ALVEOLAR PROCESSES, CHEEK, FLOOR OF MOUTH, HARD AND SOFT PALATES—CASES PROVED BY BIOPSY

Year	No. of Cases	Years of Survival															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Living
1926	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
1927	5	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	
1928	3	3	1	1	1	1	1	1	1	1	1	0	0	0			
1929	5	4	1	0	0	0	0	0	0	0	0	0	0				
1930	2	1	1	1	1	1	1	0	0	0	0	0					
1931	8	3	2	2	2	2	1	1	1	1	1						1
1932	10	9	5	4	4	4	4	3	2	2							2
1933	15	9	6	5	4	4	4	3	3								3
1934	7	3	1	1	1	1	1	1									1
1935	9	6	4	0	0	0	0										
1936	8	6	3	2	2	2											1
1937	11	9	7	5	4												4
1938	10	6	5	3													3
1939	12	11	6														6
1940	21	14															14
Cases	129	129	108	96	86	75	67	58	51	36	26	18	16	11	8	3	36
Survival		88	46	28	23	18	13	10	8	5	3	1	1	1	1	1	
Per cent		70	42	30	26	24	20	17	16	14	11						
Lost		1 (Considered no survival)															

implants and/or application of radium incorporated in a dental mold. In the later years external irradiation was given to two or three overlapping fields, 200 to 300 r daily for twenty to twenty-eight days, to the limit of skin tolerance. Almost all lesions received 5,000 to 9,000 gamma-ray roentgens from the radon implants. Some were treated first with a radium mold, 3 to 5 T.E.D., then with external irradiation and usually radon, also.

Recurrences usually were treated with more radon and external irradiation. If there was extension to the antrum, the antrum was opened and the tumor removed surgically. One to four radium capsules were then packed in the cavity, depending upon its size. The dose was 500 to 2,500 mg.-hours in ten to thirty hours, depending upon the number of capsules used. The capsules contained 25 mg. of radium each, filtered with 2 mm. of brass. Treatment to the cervical nodes has been discussed.

Table VI gives results at other clinics.

*Carcinoma of Lower Alveolar Process (Positive Biopsy):* There were 23 cases of carcinoma of the lower alveolar process with positive biopsy. Thirteen cases were treated up to and including 1936, with 5 (38 per cent) five-year survivals. Five of

the 13 patients had metastases at the time of admission. None of these lived two years after the onset of treatment and all died with disease. (Two who did not have a biopsy had positive clinical evidence of metastases and were alive after five years.) Eight of the 13 patients had no metastases on admission. In 6 of these the disease was controlled; 5 lived over five years free of disease, and one four years.

Ten patients were treated after 1936; 7 had no metastases on admission; 3 had metastases. In none did metastases appear later. Of the 7 with no metastases, 4 are living and free of disease, 1 three years, 1 two years, and 2 one year. Three of these four were treated by radiation alone. None of the 3 with metastases lived two years after beginning treatment.

If the carcinoma has invaded the mandible, surgery is the method of choice. If all the tumor cannot be excised, supplementary radiation in the form of radon implants and external radiation should be given. Many of these patients are poor surgical risks and these should be given intensive irradiation unless the prognosis is utterly hopeless. If radionecrosis does occur, the affected portion of the mandible can be excised before too much pain ensues.

TABLE VI: RESULTS OF TREATMENT IN CARCINOMA OF THE UPPER ALVEOLAR PROCESS

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Holmgren (20)	39	25% (5 years)	Surgical
König (20)	48	16% (5 years)	Surgical
Martens (20)	79	20% (5 years)	Surgical
Welch (21)	137	17% (5 years)	Mostly surgical
New and Figi (22)	295	43% (5 years)	Surgical diathermy and radiation
Lund and Holton (23)	34	12% (5 years)	Radiation and surgery
Hautant (20)	18	38% (1½-5 years)	Radiation and surgery
Barnes (20)	25	52% (1-9 years)*	Radiation and surgery
Green (20)	36	33% (1-5 years)	Radiation and surgery
New (20)	97	36% (1-8 years)	Radiation and endothermy
Lierle (24)	16	31% (3-7 years)	Radiation
Berven (20)	44	18% (4 years)	Radiation and surgery
Author	15	47% (5 years)	Radiation and surgery

\* Cases without metastases only.

TABLE VII: RESULTS OF TREATMENT IN CARCINOMA OF THE LOWER ALVEOLAR PROCESS

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Simmons (25)	14	26% (5 years)	Surgery alone
Welch and Nathanson (21)	237	12.5% (5 years)	Mostly surgery
Geschickter (26)	Representative group	25% (5 years)	Surgery with little radiation
Lund and Holton (23)	68	15% (5 years)	Mostly surgery
New and Figi (22)	87	40% (5 years)	Surgery and radiation
Berven (20)	61	18% (5 years)	Radiation and endothermy
Regaud (20)	Representative group	16% (5 years)	Radium
Author	12	38% (5 years)	Radiation and surgery

When there is no invasion of the mandible, irradiation is preferred, as a rule, since these lesions show a good response. There are some cases, however, with no invasion of the mandible where surgery may be the method of choice, that is, small lesions with metastases to the submaxillary or upper cervical nodes. In such cases, dissection of the lesion and involved nodes can be done in one stage. Early localized lesions are probably equally well controlled by irradiation and by surgery, but irradiation is a less formidable procedure.

We have treated these lesions by external irradiation and radon implants in the same manner as lesions of the upper alveolar process. Some of the cases were treated with the radium dental mold plus external irradiation as previously described.

*Carcinoma of the Cheek (Positive Biopsy):* There were 49 cases of carcinoma of the cheek with positive biopsy. Five (18 per cent) five-year survivals were obtained in 28 cases treated up to and including 1936.

Of these 28 patients, 21 had metastases at the time of admission, while 1 with no metastases on admission developed metastases later. One with metastases survived five years. Seven of those patients treated up to and including 1936 had no metastases on admission. Four of these are included among the five-year survivals.

Twenty-one cases were treated after 1936—6 (30 per cent) with metastases (compare this with 75 per cent with metastases before 1936) and 15 with no metastases. Three of those with no metastases had metastases later. Of the 6 with metastases, 2 are living over two years free of disease (both had unilateral neck dissections) and the remaining 4 died with cancer. Ten (48 per cent) of the 21, including those with metastases, are free of disease, 3 for four years, 1 for three years, 4 for two years (1 died of intercurrent disease), and 2 for one year. All are alive but the one indicated.

The above figures show that 75 per cent of the cases treated before 1937 had metas-

TABLE VIII: RESULTS OF TREATMENT IN CARCINOMA OF THE CHEEK

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Steiner (Martin and Pflueger, 4)	33	9% (3 years)	Surgery
Morestin (4)	26	11% (3 years)	Surgery
Geschickter (26)	Representative group	10% (5 years)	Surgery and radiation
Welch and Nathanson (21)		22% (5 years)	Surgery and radiation
Berven (4)	81	26% (5 years)	Radiation and surgery
Forssell (25)	160	30% (5 years)	Surgery and radiation
Pfahler (28)	177	27% (5 years)	Radiation and surgery
Lund and Holton (23)	69	16% (5 years)	Radiation and surgery
Schreiner and Simpson (4)	30	20% (5 years)	Radiation only
Regaud (4)	47	19% (5 years)	Radiation only
Martin, C. L. (29)	40	30% (5 years)	Weak radium needle technic
Martin and Pflueger (4)	99	30% (5 years)	Radiation and surgery
Author	28	18% (5 years)	Radiation and surgery

tasized at the time of admission, compared to only 30 per cent of those seen from 1937 to 1940, inclusive. The number of cases treated during the two periods was approximately equal. Since our five-year survival rate must be taken from cases treated before 1937, this explains the rather low five-year survival rate of 18 per cent.

In our experience this has been a difficult condition to treat. Most lesions were treated with radon implants, with doses of 7,000 to 10,000 gamma-ray roentgens to the center of the tumor, plus external irradiation. Some were given 500 to 800 mg. hours with the radium mold plus external irradiation.

Results of treatment by surgery alone have not been encouraging. Small early lesions in the anterior portion of the cheek are amenable to surgery. Lesions further back are more prone to metastasize and are best treated by a combination of radiation and surgery or radiation alone. Most of the lesions were extensive when first seen and the incidence of metastases was high (55 per cent), higher than for any other site except the soft palate (70 per cent). The lesion also frequently extended to areas such as the lateral pharyngeal wall or palate, inaccessible to surgery. Albright (2) quotes Pólya, who, "with wide experience in plastic surgery of this region, warns that extensive removal of the buccal mucous membrane leads to scar formation, contraction, and inability to open the mouth."

Table VIII gives results of treatment from other clinics.

*Carcinoma of the Floor of the Mouth (Positive Biopsy):* There were 21 proved cases of carcinoma of the floor of the mouth, with only one (9 per cent) five-year survival among 11 cases treated up to and including 1936. This patient had a Stage II lesion and was treated by radiation alone. Six (54 per cent) of the 11 patients had metastases on admission, and all of these died with disease. Five had no metastases on admission. One of these died after six years, free of disease, and one after two years; another died in less than a year but free of disease. After 1936, 10 cases were treated—3 with metastases and 7 with no metastases. The resulting figures are naturally more encouraging. Three with metastases died with disease. Of the 7 with no metastases, 1 is living four years free of disease, 1 two years, 2 one year.

Most authors admit inoperability of these lesions unless they are 1 cm. or less in diameter. Larger lesions are inoperable because of extension to the tongue and mandible. Radiation therapy is indicated, since it is less mutilating and gives better results. Radiation was given through portals over the rami of the mandible and to the floor of the mouth from below. In some instances a cone was used to irradiate the lesion directly through the mouth. The amount of radiation which can be given is limited because of the danger of osteoradionecrosis. External radiation was supplemented by radon implants and/or radium mold. The best results were obtained in the Stage II lesions; treatment

TABLE IX: RESULTS OF TREATMENT IN CARCINOMA OF THE FLOOR OF THE MOUTH

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Geschickter (26)	Not stated	20% (5 years)	Surgery
Lund and Holton (23)*	58	14% (5 years)	Mostly surgery
Welch (21)	250	8% (5 years)	Surgery and radiation
Pfahler (28)†	25	16% (5 years)	Radiation
Regaud (5)	77	22% (5 years)	Radium
Martin and Sugarbaker (5)	103	25% (5 years)	Radiation and surgery
Berven (20)	32	34% (5 years)	Teleradium and endotherapy
Author	11	9% (5 years)	Radiation and surgery

\* Cases with small nodes not necessarily malignant. † Figures revised to compare with ours.

was without effect on the Stage IV lesions. Since large lesions of the floor of the mouth usually cross the mid-line, cervical metastases in such cases are almost always bilateral, which partially explains the poor prognosis in Stage IV.

Table IX gives results of treatment from other clinics.

radium mold were used. Extension to the antrum was treated as previously described.

Table X gives results of treatment from other clinics.

*Carcinoma of the Soft Palate (Positive Biopsy)*: There were 8 cases of carcinoma of the soft palate with positive biopsy.

TABLE X: RESULTS OF TREATMENT IN CARCINOMA OF THE HARD PALATE

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Welch (21)	174	19% (5 years)	Mostly surgery
Geschickter (26)	Not stated	10% (5 years)	Surgery
Lund and Holton (23)	42	14% (5 years)	Mostly surgery
Lierle (24)	9	22% (5-7 years)	Radiation and surgery
Pfahler (28)	76	20% (5 years)	Radiation
Regaud (26)	Not stated	4% (5 years)	Radium

*Carcinoma of the Hard Palate (Positive Biopsy)*: There were 10 cases of carcinoma of the hard palate with positive biopsy. No five-year survivals were obtained in the 6 cases treated up to and including 1936. Two (20 per cent) of 10 patients treated up to and including 1939 are alive after three years. Of the 6 patients treated before and including 1936, 2 had metastases on admission, in 2 metastases developed later, and 2 were without metastases. One lived over three years, but all died with disease. After 1936, 4 cases were seen, 3 with no metastases and 1, an adenocarcinoma, with metastases. One of the patients with no metastases lived over three years and died free of disease. He was treated by radiation only.

Carcinoma of the hard palate is best treated by a combination of surgery and radiation. Surgery in our cases consisted of electrocoagulation of the lesion. External irradiation, radon implants, and the

Three of these were among those treated up to and including 1936. All 3 had metastases and none lived as long as a year. They were given palliative treatment only. Five patients were seen after 1936; 2 with metastases lived less than one year. The 3 with no metastases were treated in 1940, and all are living and free of disease.

#### SUMMARY AND CONCLUSIONS

1. A review has been presented of 129 cases of carcinoma of the alveolar processes, cheek, floor of the mouth and palate, with positive biopsy. The five-year survival rate of 24 per cent compares favorably with survival rates reported from other clinics. In addition, the survival rates for each site have been reported separately and various data as to treatment, complications, etc., have been included.

2. By the proper use and control of radiation alone, or radiation and surgery combined, good results can be obtained in

Stage I, Stage II (no local extension), and Stage III (local extension but no metastases) lesions. Sixty-one per cent of Stage II lesions and 60 per cent of Stage III lesions were controlled for one to five years in this series.

3. Better results may be expected in the future: (a) for the primary lesion by the increased use of direct intra-oral therapy in combination with the present methods of irradiation, and possibly by the more generalized use of higher kilovoltages, up to 400 kv.; (b) for cervical metastases by possibly more vigorous radiation in combination with surgery for operable metastases and by more localized and, therefore, more intense irradiation of inoperable metastases; (c) in general, by education of the public, dentist, and physician in regard to early recognition of the malignant lesion.

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# Streamlining X-Ray Therapy for Wartime Service<sup>1</sup>

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SOME FORTY-SEVEN years ago, while still an undergraduate, the writer operated a static machine for Dr. H. G. Brainerd of Los Angeles, with which he essayed x-ray diagnosis and conducted experiments with treatment. One day Dr. John B. Murphy of Chicago appeared with a colleague suffering from pain in the kidney, with purulent and bloody urine. Doctor Murphy, suspecting stone, asked if we could make a diagnosis and we made a heroic attempt. An hour's exposure was made, but the x-ray plate was not diagnostic. Another exposure of one and a half hours' duration gave a faint shadow of the spine and abdominal organs, but this was still not sufficient for diagnosis. A few days later the patient's pain had ceased and pus and blood were no longer present in the urine. Within two weeks' time Doctor Murphy pronounced him symptom-free. In other words, it appeared that a therapeutic effect, entirely unexpected, had been achieved. Fortunately, no untoward sequelae developed on the skin or elsewhere, which we now know was due to the absence of quantitative long-wave radiation. This incident awakened a lasting respect for the possibilities of radiation therapy, which leads to the subject at hand; namely, streamlined radiation therapy for present wartime service.

Bridging the time since radiation therapy took its first faltering footsteps, let us briefly review its present-day status as a healthy young adult, acclaimed and acknowledged in all intellectual medical centers as a highly specialized and integral part of the practice of medicine. It is futile at present to dream of or await the arrival of multimillion-volt x-ray equipment. This is well on the way and in due time will

find its ultimate place in radiation therapy. Meanwhile, let us correlate known facts and factors and adopt a common-sense, middle-ground working technic.

Equipment for x-ray therapy may now be accepted as standard, provided it is obtained from a manufacturer of known repute. All such apparatus, irrespective of name, can be integrated and made adaptable for any or all types of therapy which time and experience have proved effective. Many pioneer radiologists have, over a long period of years, placed x-ray therapy upon a solid and sane foundation.

The essentials for the average x-ray therapy department are as follows: low-voltage apparatus with a maintained capacity for 100 kv. at the tube's target; high-voltage apparatus with a maintained capacity for 200 kv. at the tube's target; adequate space for placing transformers, control cabinets, connecting lines, treatment tables, and necessary equipment, so as to facilitate therapeutic procedures to the best possible advantage.

Particular care must be exercised in providing effective protection from back-scattering, stray radiation, and potential direct or indirect radiation.

Cones and filters are necessary adjuncts to x-ray therapy and play a major role in securing accuracy of dosage for the prescribed number of roentgens to be administered. In our Los Angeles Tumor Institute we have standardized our cones and filters so as to take a conservative position between extremes. Skin and superficial treatments are coned to a skin-target distance of 30 cm. under 100-kv. generators; filters vary from 1 mm. of aluminum to 0.25 mm. of copper, according to desired depth and intensity. Adenopathies and

<sup>1</sup> Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

The opinions and assertions contained herein are the writer's. They are not official nor do they reflect the views of the Medical Department of the U. S. Navy.



other superficial pathologic conditions are coned to 50 cm. skin-target distance under 200-kv. generators, with 0.5 to 1.0 mm. copper filter. All deeply located conditions are also coned to 50 cm. skin-target distances with heavier filters to suit higher voltages.

One hundred- and 200-kv. x-ray generators are available everywhere, and the international dose equivalent is expressed in roentgens by the accepted sign "r." We are submitting herewith tables showing a suggested alignment of voltage, amperage, cones, target-skin distance, filters, and time factors, which, together with proper calibration and known r output per minute, will provide a basis for accurate dosage available to all military facilities where radiation therapy is utilized.

X-RAY THERAPY FACTORS FOR 100 AND 200 KV. IN USE AT THE LOS ANGELES TUMOR INSTITUTE

High Voltage

Kv. 200	
Ma. 4	
T.S.D. 50 cm.	
Filters	
0.5 mm. Cu + 1.0 mm. Al	
1.0 mm. Cu + 1.0 mm. Al	
Cones	
2 cm. diameter	} Round cones for intra-oral use
3 cm. diameter	
5 × 5 cm.	
10 × 10 cm.	
10 × 15 cm.	
15 × 15 cm.	
20 × 20 cm.	
All cones contain 1.0 mm. of aluminum, so that this part of the filter cannot be omitted.	

Low Voltage

Kv. 100	
Ma. 4	
T.S.D. 30 cm.	
Filters	
1.0 mm. Al	
2.0 mm. Al	
3.0 mm. Al	
4.0 mm. Al	
0.25 mm. Cu + 1.0 mm. Al	
Cones	
1 cm. diameter	} Round cones for intra-oral use
2 cm. diameter	
3 cm. diameter	
5 × 5 cm.	
10 × 10 cm.	
15 × 15 cm.	
All cones contain 1.0 mm. of aluminum, so that it is impossible to give a treatment without filter.	

In our own clinic we have found this method satisfactory over a long period of time. It must not be overlooked, however, that we are still unable to measure the

SAMPLE CALIBRATIONS OF FORMULAE GIVEN

High Voltage

Kv.....	200
Ma.....	4
T.S.D.....	50 cm.
Filter	r/min.
0.5 mm. Cu + 1.0 mm. Al.....	15
1.0 mm. Cu + 1.0 mm. Al.....	10

Low Voltage

Kv.....	100
Ma.....	4
T.S.D.....	30 cm.
Filter	r/min.
1.0 mm. Al.....	55
2.0 mm. Al.....	40
3.0 mm. Al.....	32
4.0 mm. Al.....	27
0.25 mm. Cu + 1.0 mm. Al.....	16

These sample calibrations have been certified by frequent checking. It is suggested, however, that every hospital where radiation therapy is a major activity secure the services of a full-time physicist.

patient, his own personal disease, his reactions to radiation, and his idiosyncrasies. The final results still depend very largely upon the man behind the gun.

This is the first time in American history that our sailors and soldiers have fought fanatical enemies under the worst climatic conditions this world affords, conditions to which white men are not inured. From the inconceivably bitter cold of the Aleutians to the enervating heat of the tropics, our men are coming home in steadily increasing numbers with pathological conditions of unknown origin and sinister aspect. The American medical profession will, as always before, meet and successfully cope with this emergency. From the Arctic will come new problems in the care of respiratory infections, skin injuries with trophic changes, frost-bite, and the more serious sequelae of frozen extremities. From the jungle new and more malignant types of malaria, poisons from hosts of insects and crawlers of many varieties hitherto unfamiliar, blood diseases, anemias, bizarre adenopathies, gastro-intestinal disturbances, skin and surface infections.

All this is in addition to the maimed and wounded patients. Here we find pain, inflammation, infection, and sometimes malignant growth, alone or in perplexing



Figs. 1 and 2. Keloids with infection following gasoline burns and results of radiation therapy a year later.

combination, and this is where teamwork on the part of all the staff of the hospital is paramount. Here, also, is where radiation therapy will exert its best influence, and the writer earnestly urges all hospital radiologists to co-operate.

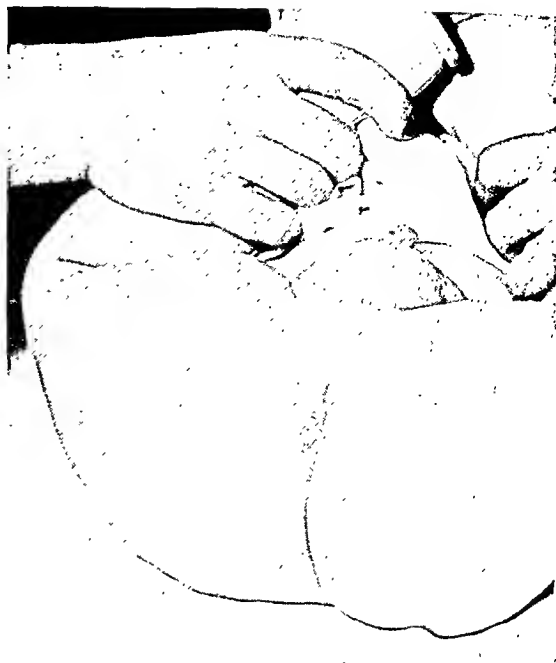
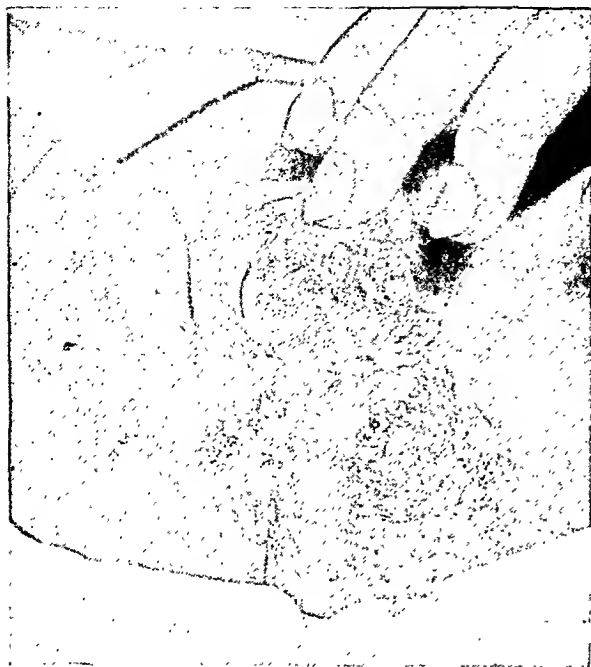
Since my return to active duty, a large number of casualties have been observed at various naval hospitals on the west coast. Thus, sufficient time has elapsed to substantiate the good effect of radiation therapy, particularly in the acute inflammatory varieties of skin involvement, whether from trauma or infection, or both.

For brevity's sake, the following paragraph is quoted from a former article, "The X-Ray in the Treatment of Infection" (1):

"In looking over past case records in our own service, the following formidable array of pathologic conditions has been submitted to radiation therapy with considerable success: osteomyelitis, chondritis, dermatophytosis; acne vulgaris; furunculosis; carbuncles; ringworm; sycosis barbae; paronychia; lupus vulgaris; lupus erythematosus; erysipelas; mycosis fungoides; molluscum contagiosum; granuloma ingui-

nale; trachoma; seborrheic dermatitis; otorrhea; mastoiditis; rhinophyma; acne rosacea; rhinoscleroma; verrucae; actinomycosis; coccidioidosis; inflamed tonsils; pertussis; pneumonia; empyemic sinuses; bronchiectasis; mastitis; pruritus; condyloma; chronic salpingitis; tubercular salpingitis; encephalitis; brachial neuritis; sciatica and radiculitis."

A number of dermatologists, and not a few radiologists, advocate unfiltered x-ray therapy. While in skillful hands and under strict regulation this is permissible, yet in the writer's opinion the use of raw radiation should be discouraged. There are altogether too many chances for excessive dosage from the unscreened tube, which can easily be avoided by employing selective filters. In fact, the tendency today is to step up both voltage and filter factors, not only for depth dosage but in treating skin and superficial disease, also. This has been strikingly demonstrated, in our past records, upon extensive surface lesions wherein supervoltage therapy was successful in clearing up certain conditions which had become static to cautery and



Figs. 3 and 4. Infected angioma of the scrotum in an infant before and a year after radiation therapy. The child is now (1944) ten years old and entirely normal.

ordinary x-ray and radium applications. In any event, radiation therapy is available in practically all military hospitals with men well versed in its use. Therefore, there appears to be no plausible excuse for not getting full service from this singularly effective therapeutic entity.

Dr. Neville Finzi, Director of the X-ray Department of St. Bartholomew's Hospital, and President of the Radiological Section, Royal Society of Medicine, London, in a recent article (2), writes: "With the very small doses now employed by some radiologists it is possible to carry on treatment, if necessary, for very long periods without the slightest risk of after-effects: this necessity, of course, arises only in the most chronic inflammations. Success has been obtained by ray therapy in such diverse conditions as carbuncle, erysipelas, suppurative parotitis, tuberculous glands, tuberculous peritonitis, actinomycosis, chilblains, whitlow, gas gangrene, osteomyelitis, and many others.

"In wounds there are two purposes to which irradiation can be put. One is the acceleration of the healing of clean wounds and the prevention of keloid; the other is to check the local inflammatory reaction,

if there is no foreign body or sequestrum present. It does not matter whether the infection is acute, subacute or chronic, except that one tends to use even smaller doses in acute cases."

In conclusion, may I request that radiologists take cognizance of the fact that strong influences are at work to discredit x-ray therapy? How can these be combated? Our American journals devoted to the science of Radiology have over the past thirty years given incontrovertible proof of the singular efficacy of radiation therapy. Perhaps the medical profession at large is not interested in our subject matter. Our diagnostic radiologists are perhaps becoming lethargic or lazy. Certainly our surgical confreres by and large are not over-enthusiastic in extending their support. Whatever the factors at work, some concerted action could well be inaugurated to insure for radiotherapy the recognition it deserves.

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# Response of the Retina to the Direct Roentgen Beam

## A Method of Assessing the Condition of the Retina and an Aid in Localizing Intraocular Foreign Bodies<sup>1</sup>

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THE FOLLOWING report of our experiences with the method described by Pirie (8) and advocated by Pancoast, Pendergrass, and Schaeffer (7), in determining the extent of retinal damage and the presence or absence of radiopaque foreign bodies, is based upon observation of 74 battle casualties with suspected

success if ophthalmoscopy alone is relied upon.

The principle employed is dependent upon the recognition of a diffuse bluish-green glow by the intact retina when exposed to a direct beam of roentgen rays.

The adequate stimulus for vision is ra-

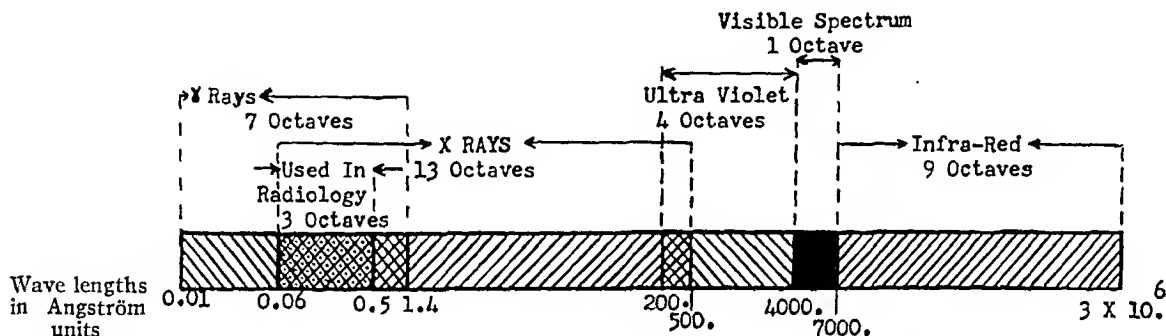


Figure 1.

ocular injuries. While in each instance radiography and fluoroscopy were utilized for localization of foreign bodies, this method provided valuable additional information.

In many instances of injury due to combat, ophthalmoscopic observation is impossible because of (a) severe edema of the lids and conjunctiva or (b) cloudy media. In these patients accurate information concerning the condition of the retina was obtained. This was helpful in planning definitive treatment. When a retinal tear or detachment can be promptly localized, there is a reasonable chance of replacing the retina by operation. Hemorrhage into the vitreous may take weeks for absorption, decreasing the chances of operative

diant energy of the visible spectrum with a range between 7,500 and 4,000 Å.U. (4) (Fig. 1). The higher figure evidently represents the limit of sensitivity of the retina to the longer wave lengths, for the media of the eye will transmit infra-red rays up to 200,000 Å.U. The lower limit of transmissibility of the shorter waves in the ultraviolet band is about 3,200 Å.U.; this figure applies only if the illumination is intense and the eye completely dark-adapted, and even then, few waves under 4,000 Å.U. reach the retina. The cornea absorbs ultraviolet rays below 2,970 Å.U., while the lens transmits only a small portion of those below 4,000 Å.U. That is to say, most of the rays between 4,000 and 2,970 Å.U. are absorbed by either the cor-

<sup>1</sup> Thesis submitted (by Lt. Comdr. Godfrey) to the Faculty of the Graduate School of Medicine of the University of Pennsylvania, toward the requirement for the degree of Doctor of Medical Science, D.Sc. (Med.), for graduate work in radiology. From the Radiologic Service. Accepted for publication in May 1944.

The opinions or assertions contained herein are the private ones of the writers, and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. (Art. 113 (2) U. S. Navy Regulations.)

nea or lens. Wave lengths between 3,500 and 4,000 Å.U. cause fluorescence in the lens (1). Thus the presence of a sufficient quantity of soft x-rays in the heterogeneous beam may have led to the suggestion that the sensation received by the retina is due to fluorescence.

The quantity of light energy necessary to stimulate the retina is not constant for all wave lengths. In the dark-adapted eye, the energy required to cause a just

tense and prolonged exposure. Dorn (3) reports no qualitative difference in the light sensation produced on the retinae of the normal and totally color-blind subject.

Proof that both the rods and cones are sensitive to x-rays may be obtained by investigating the retina while interposing a leaded plate with an aperture 1 mm. in diameter between the subject's eye and the anode. This produces the sensation of a circle approximately one-quarter of an

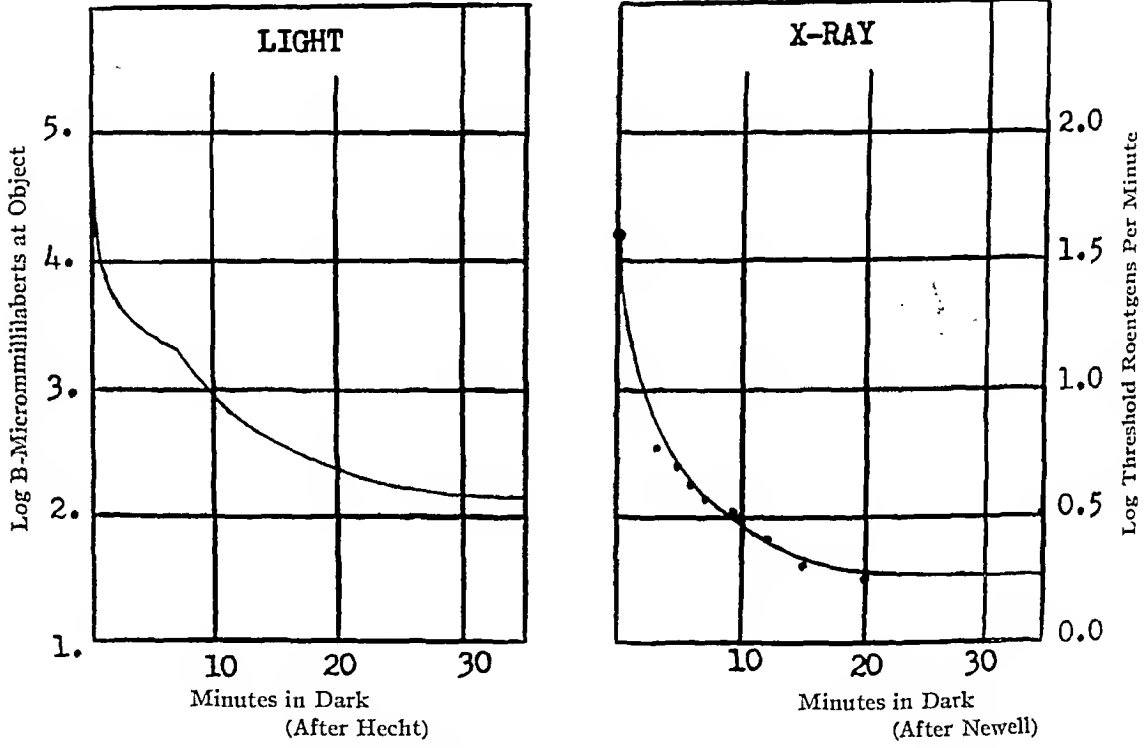


Fig. 2. Dark adaptation curves for light and x-rays.

perceptible sensation is least for green light with a wave length of 5,070 Å.U., and has been estimated at  $5 \times 10^{-12}$  ergs per second (1). The threshold value for a heterogeneous beam of x-rays has been calculated at 1/2 r per second to a spot measuring 1 sq. mm. on the retina. This amounts to an absorption of  $2 \times 10^{-5}$  ergs per second in the 50  $\mu$  thickness of the rod layer (5).

Dark adaptation curves for light and x-rays are similar (Fig. 2). Even so, Brandes and Dorn (2) were unable to demonstrate any discoloration of visual purple by roentgen rays, in spite of in-

inch in diameter at the center of the retina, and of an oval at the periphery. In spite of prolonged searching, the light spot will disappear in one area only. This is presumably the site of entry of the optic nerve. Since the macula lutea containing the fovea centralis is usually no larger than the optic disk, it is evident that the cones are stimulated by the roentgen rays and, since the sensation at the periphery of the globe is as strong as centrally, the rods must also be sensitive, as they exist exclusively in some peripheral areas. That the response is not due to direct stimulation of the optic nerve was evident when

examination of 6 patients with recent enucleation, and 1 patient with recent evisceration, disclosed an absence of response on the operated side.

Using x-rays, Newell and Borley (5) have had some success in testing visual acuity in eyes with varying grades of diminished vision resulting from opacity of the media. They tested their patients by having them resolve perforations in a stencil subtending a known angle on the retina, and were able to predict fairly accurately the improvement in vision subsequent to such operations as cataract extraction or transplantation for corneal opacity. They suggested that vitamin A may be a factor in the production of the retinal sensation. This has not been established to date.

*Technic:* The patient is placed in a darkened room for twenty minutes preceding the examination, to increase retinal sensitivity. During this interval the procedure to be undertaken is carefully explained. The subject is positioned facing the x-ray tube so that the field irradiated may be noted on the fluoroscopic screen. The examiner then ascertains the ability of the patient to recognize the retinal response to the roentgen beam with the uninjured eye. To assure comprehension and complete co-operation, the patient is required to describe accurately the effects of irregular and repeated interruptions of the current. When accuracy of observation with the uninjured eye is demonstrated, the beam is shifted to the injured side.

If the involved eye is bandaged, it is well to explain that this has no effect on the examination. Obviously, radiopaque medications, such as compounds of halogens or heavy metals, should not be incorporated in the dressings.

*Interpretation:* A homogeneous glow with direct irradiation indicates an intact retina. Absence of response may indicate either retinal detachment or a lesion involving the visual pathways. A darkened area in an otherwise homogeneous field usually can be mapped by the patient in

the presence of partial detachment, perforation, or tear of the retina. The condition of the globe, anterior to the retina, does not alter this response, since hemorrhage into or clouding of the media due to other causes does not affect appreciably the roentgen beam. Even the recent loss of vitreous fails seriously to impair the retinal response.

With clear media and an intact retina, radiopaque foreign bodies anterior to the retina appear to sparkle, when observed by the patient in the direct beam. The patient describes this scintillation as being very dim and resembling the light from a distant star. If the patient makes this observation, he can localize the particle fairly accurately in the visual field. Obviously, non-radiopaque foreign bodies cannot be ruled out, but at times a foreign body, invisible on the films, may be seen with the ophthalmoscope or described by the patient during this procedure. The sparkling is due to the fact that, upon striking a particle of heavy density, a portion of the energy of the roentgen beam is absorbed and converted, with the result that some visible light is given off. It may be this visible light that enables the retina to detect the foreign body. There should, therefore, be an uninterrupted pathway for light transmission from the foreign body to the retina. Clouding of the media or interposition of the iris absorbs the light emanating from the fragment before it can reach the retina; nevertheless, the condition of the retina may be assessed. The advantage of the latter is apparent in those instances in which direct ophthalmoscopic observation is unsatisfactory because of cloudy media.

Since x-rays are not refracted by the crystalline lens as is ordinary light, the area of the retinal defect, or the image of the foreign body, is reversed only in the higher centers and therefore is diametrically opposite to that described. Thus, if a patient describes a scintillating spot in the right eye at 2 o'clock, its actual location would be at 8 o'clock. The same holds for retinal tears.

TABLE I: CLINICAL FINDINGS IN CASES

Case, Mechanism of Injury, Eye Involved	Visual Acuity	Retinal Response	Foreign Bodies				Fragmenta- tion or Laceration of Globe
			Nature	No.	Size (mm.)	Site	
4. Bomb blast O.D.	Light	Normal	Fe	3	1	Lids, 2 Cornea, 1	.....
5. Shell fire O.D.	20/20	Normal	Al	1	2	Cornea	.....
6. Shell fire O.S.	Light	Normal	Fe	1	4	Sup. obl. muscle	Lacera- tion
8. Machine gun O.S.	15/20	Normal	Fe	3	1	Cornea	.....
9. Machine gun O.D.	Light	Normal	Fe	1	2	Periocular	.....
10. Explosion E motor O.D.	10/20	Normal	Fe	4	1	Periocular	.....
11. Shell fire O.D.	Light	Normal	Powder	Many	..	Cornea	.....
12. Land mine O.S.	Light	Normal	Powder	Many	..	Cornea	.....
15. Hand grenade O.D.	Light	Normal	.....	None	..	.....	.....
16. Bomb blast O.S.	Light	Normal	Fe	2	1	Periocular	.....
16. Bomb blast O.D.	Light	Normal	Powder	Many	..	Cornea	.....
16. Bomb blast O.S.	Light	Normal	Powder	Many	..	Cornea and conjunctiva	.....
17. Shell fire O.D.	Light	Normal	Fe	2	2	Anterior chamber, vitreous	.....
23. Welding O.D.	Light	Normal	Flux?	1	..	Cornea	.....
24. Bomb blast O.D.	Light	Normal	Fe-Al	Many	..	Cornea	.....
24. Bomb blast O.S.	Light	Normal	Fe-Al	Many	2	Cornea and periocular	.....
28. Grenade O.D.	Light	Unsatis- factory	Fe	2	3	Periocular, vitreous	.....
33. Mortar O.D.	11/20	Normal	Al?	4	..	Cornea, 3 Vitreous, 1	Lacera- tion
34. Shell fire O.D.	20/20	Normal	Al?	1?	..	Sclera	.....
40. Bomb blast O.D.	Light	Normal	Fe	1	2	Cornea	.....
46. Bomb blast O.D.	Light	Normal	Fe-Al	2	2	Anterior chamber	.....
47. Machine gun O.D.	4/20	Normal	Glass	2	3	Cornea	.....
48. Grenade O.D.	20/20	Normal	Fe	1	1	Cornea	.....
49. Machine gun O.S.	15/20	Normal	Glass	1	2	Cornea	.....
51. Rifle O.D.	15/20	Normal	Powder	25	..	Cornea and conjunctiva	.....
53. Bomb blast O.S.	Light	Normal	Fe	1	5	Periocular	Lacera- tion
54. Shell fire O.S.	Light	Normal	Fe	1	10	Periocular	Fragment- ation
55. Bomb blast O.S.	Light	Normal	.....	None	..	.....	.....
56. Bomb blast O.D.	Light	Normal	.....	None	..	.....	.....
56. Bomb blast O.S.	Light	Normal	.....	None	..	.....	.....



## WITH NORMAL RETINAL RESPONSE

Cornea	Anterior Chamber	Iris	Lens	Vitreous	Retina	Optic Nerve	Case
Ulcer	Clear	Normal	Clear	Clear	Edema	Normal	4
Perforated	Clear	Normal	Clear	Clear	Intact	Normal	5
Perforated	Cloudy	Torn	?	?	?	Normal	6
Uleers	Clear	Normal	Clear	Clear	Intaet	Normal	8
Clear	Clear	Synechia	Opaque	?	?	Normal	9
Uleer	Clear	Normal	Clear	Clear	Intact	Normal	10
Uleers	Clear	Normal	Clear	Clear	Intact	Normal	11
Clear	Clear	Normal	Clear	Clear	Intact	Normal	
Hazy; ulcers	Clear	Normal	?	?	?	Normal	12
Clear	Cloudy	Normal	Clear	?	?	Normal	15
Ulcers	Clear	Normal	Clear	Clear	Edema	Normal	16
Scars	Clear	Normal	Clear	Clear	Intact	Normal	
Clear	Clear	Normal	Clear	Cloudy	?	Normal	17
Opaque	Clear	Normal	?	?	?	Normal	23
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	24
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	
Perforated	Clear	Normal	Clear	Clear	Intact	Normal	28
Clear	Clear	Normal	Clear	Clear	Intaet	Normal	33
Clear	Clear	Normal	Clear	Clear	Intaet	Normal	34
Ulcers	Cloudy	Normal	Clear	Hem.	?	Normal	40
Scars	Clear	Normal	Clear	Hem.	Edema	Normal	46
Ulcers	Clear	Normal	Clear	Clear	Intaet	Normal	47
Ulcer	Clear	Normal	Clear	Clear	Intaet	Normal	48
Ulcer	Clear	Normal	Clear	Clear	Intaet	Normal	49
Uleers	Clear	Normal	Clear	Clear	Intaet	Normal	51
Perforated	Clear	Normal	Clear	Clear	Edema	Normal	53
Hazy	Lost	Torn	Dislocated	Eseaped	?	Normal	54
Clear	Hem.	Irregular	Clear	?	?	Normal	55
Clear	Clear	Normal	Clear	Clear	Edema	Normal	56
Clear	Clear	Normal	Clear	Clear	Edema	Normal	

TABLE II: CLINICAL FINDINGS IN CASES

Case, Mechanism of Injury, Eye Involved	Visual Acuity	Retinal Response	Foreign Bodies				Fragmentation or Laceration of Globe
			Nature	No.	Size (mm.)	Site	
1. Shell fire O.D.	0	Normal seint.	Fe	10-12	1	Cornea, 3 Vitreous, 6-8	Laceration
2. Shell fire O.D.	0	Absent	Fe-Al	2	45-15-2	Vitreous	Laceration
3. Mortar O.S.	0	Absent	Fe	1	15-5-2	Vitreous	Laceration
7. Bomb blast O.S.	Light	Retinal tear	Fe	3	1	Upper lid	.....
12. Land mine O.S.	0	Absent	.....	None	....	.....	Fragmentation
13. Shell fire O.S.	0	Absent	Fe	1	10-5-2	Periocular	Fragmentation
14. Shell fire O.D.	0	Absent	.....	None	....	.....	Fragmentation
18. Shell fire O.S.	0	Absent	Fe	1	8-6-2	Vitreous	Laceration
19. Shell fire O.S.	0	Absent	Debris	Many	Minute	Anterior chamber	Laceration
20. Shell fire O.S.	0	Absent	Fe	1	7-5-5	Sphenoid sinus	Laceration
21. Shell fire O.S.	0	Absent	Fe	1	30-15-7	Globe	Fragmentation
25. Shell fire O.D.	0	Absent	Fe	2	3-5-2	Periocular	Fragmentation
26. Shell fire O.D.	Light	Normal seint.	Fe	15-18	3-2-2	Cornea, lens, vitreous	Laceration
27. 40-mm. shell O.S.	0	Absent	Fe	5	10-5-5	Periocular	Fragmentation
29. Shrapnel O.S.	0	Absent	Fe	7	1	Lens	Laceration
30. Shell fire O.S.	0	Absent	Fe	1	15-15-3	Vitreous	Laceration
31. Torpedo O.S.	0	Absent	Fe	8	1	Globe	Fragmentation
32. Shell fire O.S.	0	Absent	Al	1	2-2-1	Vitreous	Laceration
35. Mortar O.S.	0	Absent	Fe	3	1	Cornea	Fragmentation
36. Pom-pom 1.1 O.S.	0	Absent	Fe	1	5-3-1	Periocular	Laceration
37. Mortar O.S.	0	Absent	Fe	Many	1	Globe	Fragmentation
39. Shell fire O.D.	0	Absent	Brass	Many	7-5-2	Periocular	Laceration
41. Bomb O.S.	0	Absent	Debris Al	Many	....	.....	Laceration
42. Machine gun O.S.	0	Absent	Fe, Brass	10	1	Globe	Laceration
43. Rifle O.D.	Light	Absent	Fe, Brass	15	1	Cornea	Laceration
43. Rifle O.S.	Light	Normal seint.	Pb	4	1	Cornea, 2 Vitreous, 2	Laceration
52. Grenade O.S.	Light	Retinal tears	Fe	25-30	1	Cornea, 18 Ant. cham., 1 Iris, 2	Laceration

The depth of penetration of a foreign body  
 $\sim \frac{\text{mass} \times \text{speed}^2}{\text{frontal area}}$ . Mass  $\sim$  volume  $\times$   
density, and frontal area  $\sim$  volume  $^{2/3}$  (6).

It can be reasoned, therefore, that larger  
foreign bodies will tend to penetrate deeper  
than smaller ones. In general, this was  
true in the cases that we observed. If the

## WITH ALTERED RETINAL RESPONSE

Cornea	Anterior Chamber	Iris	Lens	Vitreous	Retina	Optic Nerve	Case
Perforated	Clear	Hem. 4 o'clock	Clear	Hem.	Intact	Normal	1
Opaque	Cloudy	?	?	Lost	?	?	2
Clear	Hem.	?	?	Cloudy	?	?	3
Clear	Clear	Normal	Clear	Clear	Partial detachment	Normal	7
Opaque	Lost	Lost	Dislocated	Lost	Destroyed	?	12
Lost	Lost	Lost	Lost	Lost	Destroyed	?	13
Lost	Lost	Lost	Dislocated	Lost	?	?	14
Perforated	Clear	Protruding	Opaque	Hem.	?	?	18
Torn	Debris	Prolapsed	?	?	?	?	19
Perforated	Lost	Torn	Dislocated	Lost	Destroyed	?	20
Clear	Hem.	Torn	Dislocated	Lost	Destroyed	Severed	21
Opaque	?	Lost	Lost	Lost	?	Severed	25
Perforated	Lost	Torn	Dislocated	Clear	Intact	Intact	26
Perforated	Cloudy	Irregular	Clear	Hem.	?	?	27
Perforated	Clear	Torn	Opaque	?	?	?	29
Clear	Clear	Normal	Clear	Lost	Torn	Severed	30
Perforated	Lost	Torn	Dislocated	Lost	?	?	31
Perforated	Lost	Torn	Dislocated	Lost	?	?	32
Opaque	Lost	Torn	Dislocated	Lost	?	?	35
Clear	Clear	Normal	Clear	Clear	Detached	?	36
Lost	Lost	Lost	Lost	Lost	?	?	37
Perforated	Cloudy	Torn	Dislocated	?	?	?	39
Clear	Hem.	?	?	?	?	?	41
Perforated	Clear	Normal	Dislocated	Hem.	?	?	42
Perforated	Clear	Coloboma	Clear	Hem.	Intact	Normal	
Perforated	Clear	Torn	Clear	Clear	Intact	Normal	43
Clear	Clear	Normal	Hazy	Hem.	Partial detachment	Normal	52

foreign body penetrated to the vitreous, its size usually was such as to produce sufficient visible light under bombardment for it to be detected by the patient. Like-

wise, a foreign body possessing sufficient mass and velocity to perforate the retina should produce an observable defect.

In some instances, the patients were able

to estimate the number of foreign bodies present. Thus, one patient (Case 1) could detect 6 to 8 scintillating spots which were interpreted as foreign bodies. Another (Case 52) was able to outline two areas representing retinal tears.

#### DISCUSSION

Of the 74 patients examined with direct irradiation, 41 were interpreted as having a normal response bilaterally; 33 described either an altered response, scintillation, or complete absence of visual stimulus in one or both eyes. Fifteen of the patients with a normal retinal response bilaterally are not included in the tables, as in these cases there was no direct ocular damage; 7 patients with operative removal of damaged globes prior to admission are also omitted. Of the remaining cases, those with a normal retinal response are briefly described in Table I, while the condensed clinical findings on those showing a variation from the normal are presented in Table II.

In 10 patients injury was due either to blast or the combination of blast with metallic foreign bodies (Cases 4, 7, 16, 24, 40, 46, 52, 53, 55, and 56). In two (Cases 7 and 52), retinal tears were present. Both patients mapped the torn areas on exposure to direct roentgen rays. In neither did metallic fragments penetrate to the vitreous, and we feel that the retinal tears were due to transmitted pressure. Confirmation of the tears was obtained by direct ophthalmoscopic findings.

The remaining 8 described a normal retinal response. By ophthalmoscopy the retina appeared normal in 1. Hemorrhage into the vitreous prevented direct observation in another. Petechial hemorrhages and edema of the retina were seen in 6, and it is to be noted that in the absence of permanent retinal damage, the retinal responses were normal.

Three patients described scintillating spots on direct roentgenoscopy (Cases 1, 26, and 43). All three had foreign bodies in the vitreous. In one patient (Case 43) these were removed operatively. Another

(Case 1) had multiple small metallic splinters that were so numerous and of such a size as to contraindicate operative intervention. The third patient (Case 26) subsequently required an evisceration because of extensive ocular damage and associated infection.

As previously pointed out, we were able to predict an intact retina in 9 patients in whom ophthalmoscopic observation was impossible because of hemorrhage into or clouding of the media; while in 15 instances in which ophthalmoscopy was impossible, retinal destruction was predicted.

There was one instance of which we are aware in which the condition of the retina was not properly assessed. Though the retinal response was reported absent bilaterally (Case 42), the patient subsequently had light perception in his right eye.

#### CONCLUSIONS

1. The sensitivity of the retina to x-rays is discussed.

2. This method, in its present development, is of value in limited cases and as an adjuvant to the tests employed by ophthalmologists, in assessing the condition of the retina.

3. Occasionally intraocular foreign bodies may be detected by the subject or observed with the ophthalmoscope when the x-ray beam traverses the globe to reach the intact retina.

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# Traumatic Pneumocephalus<sup>1</sup>

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**P**NEUMOCEPHALUS or intracranial pneumatocele is sometimes encountered after fractures involving the sinuses and mastoids. Occasionally it occurs as a result of infection with gas-producing organisms or as a result of an intracranial tumor eroding into the sinuses. Most of the reported cases followed fractures. The mechanism of production after fracture involves a break in the wall of the skull, through which air can be forced either by increased external pressure or by a ball-valve action of a piece of tissue or bone. With compound fractures not involving the sinuses or middle ear, there is no simple mechanism whereby increase in the external pressure can initiate intracranial air collections. With coughing, sneezing, swallowing, and blowing the nose, the pressure in the sinuses and mastoids is momentarily increased and when fractures occur through these regions air may be forced through the fracture site into the cranial cavity.

## TYPES

Pneumocephalus may be either extracranial or intracranial. Extracranial collections of air occur in the subaponeurotic space of the scalp. They follow a break in the outer wall of the frontal sinuses or mastoid air cells. With increased pressure, air can be forced out to form swelling in the loose tissues.

Intracranial collections are the more common type, the air being located in the subarachnoid space, the subdural space, the brain, or the ventricles.

Air in the subarachnoid space usually arises from fractures in the posterior ethmoidal and sphenoidal cells and is often accompanied by a meningitis. Subdural air usually follows fractures through the posterior walls of the frontal sinuses, as there is a large potential space in the frontal region. This type may be unilateral.

Intracerebral collections are one of the more common types and may be associated with subdural air. The air may be in the brain substance or ventricular system. Air may be demonstrated in either the subarachnoid or ventricular spaces or both, depending on the extent of adhesions, the location of the fracture, and the amount of external pressure.

## DELAYED DEVELOPMENT

In a number of the reported cases, and in the case to be recorded here, the pneumocephalus *developed after a latent period* of several days up to several months. In Dandy's series of cases reported in 1926, only 6 of 24 traumatic cases for which the time interval was stated showed the pneumocephalus before one week; in 3 more it was evident before a month. In 10 it developed during the fourth to sixth weeks and in 5 at later dates, specifically 2 at two months and 1 each at three months, seven months, and ten months. The usual interval before recognition is about one month. The reason for this latent period has not been determined. It is our impression that the immediate surrounding hemorrhage and edema may be a factor in preventing the passage of air into the subdural region. Also, during the first few weeks the patient is usually at bed rest. After a latent period during which the edema regresses and healing progresses, the patient becomes more active and it is at this time, three to four weeks after injury, that the air becomes manifest in a number of cases.

The factor which precedes the recrudescence of symptoms is often blowing the nose, sneezing, or unusual activity. The patient may report that there is a flow of clear fluid from the nose following blowing or sneezing. This is a pathognomonic sign of skull fracture involving the sinuses and is present in a large number of cases of pneumocephalus.

<sup>1</sup> Accepted for publication in April 1944.

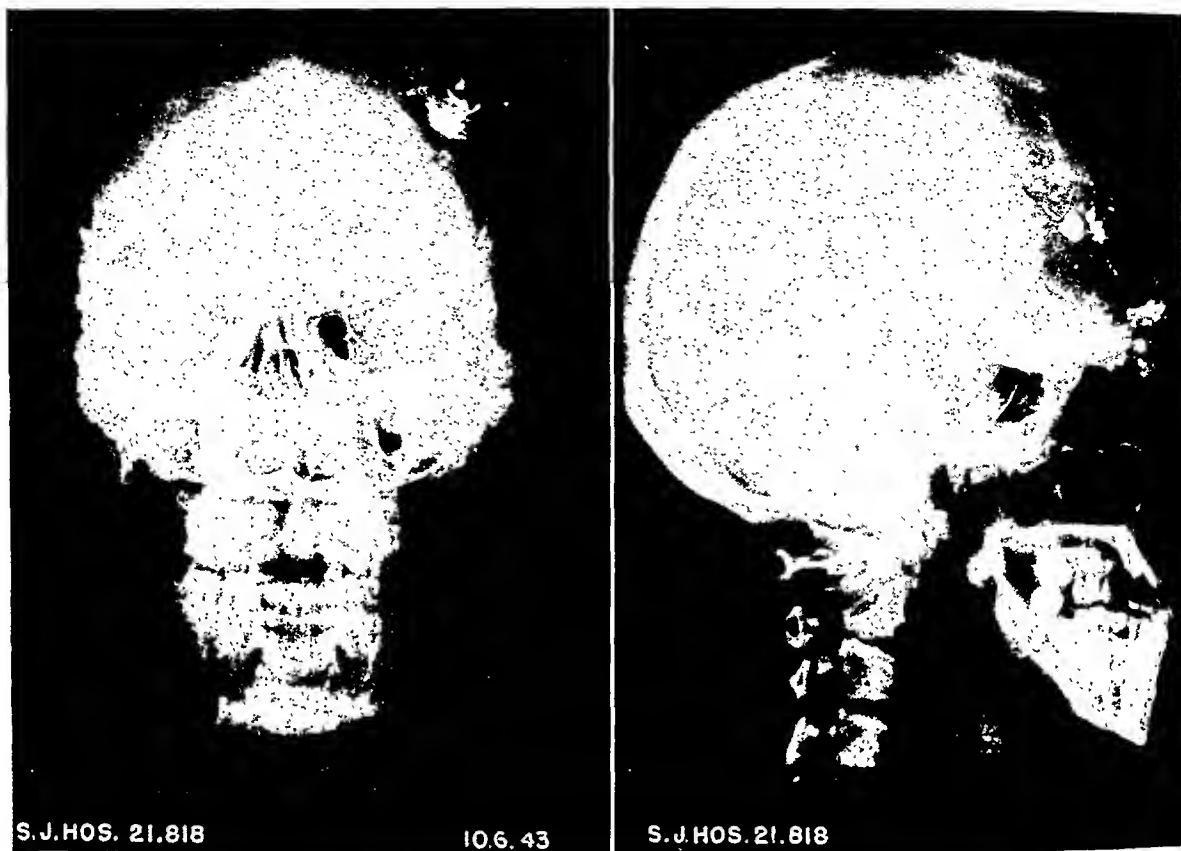


Fig. 1. Roentgenograms made Oct. 6, 1943, about four weeks after injury, showing metallic fragments and stellate fractures. No intracranial air is shown.

#### SYMPTOMS AND PROGNOSIS

The symptoms at this time may be extremely mild, as pneumocephalus is occasionally found only incidental to examination and may be overlooked if x-ray studies are not made. Usually, however, there is a varying degree of central nervous system irritation, often associated with a meningismus or signs of increased intracranial pressure. Headache then develops, associated with vomiting, drowsiness, diplopia, dizziness, and often rhinorrhea. With further increased intracranial pressure, there occur delirium and coma. The differential diagnosis following this sequence must take into consideration brain abscess, subdural hemorrhage, and meningitis. Without roentgen study, pneumocephalus may be incorrectly diagnosed as one of these three conditions, because they are more common.

The mortality is around 40 per cent. Death is usually due to meningitis. Surgi-

cal exploration, with closure of the dural wound, may be necessary. The duration of the intracranial air shadows is related to the amount of air which is forced through the opening and the length of time the opening is patent.

In 1926, Dandy reviewed a group of cases collected from the literature and added 3 of his own. Of these, 25 were traumatic, 1 followed erosion of the sinus wall from chronic infection, 1 followed erosion of the floor of the skull by a tumor, and 1 showed air in an abscess cavity and ventricle three days after mastoid surgery. Since that time a number of cases have been recorded, usually as single case reports. In 1934, Smith and Malcolmson collected 43 cases and added 2 of their own. It is probable that this condition will be of more frequent occurrence with the increased number of skull injuries in the present war.

The case we are reporting (with sponta-

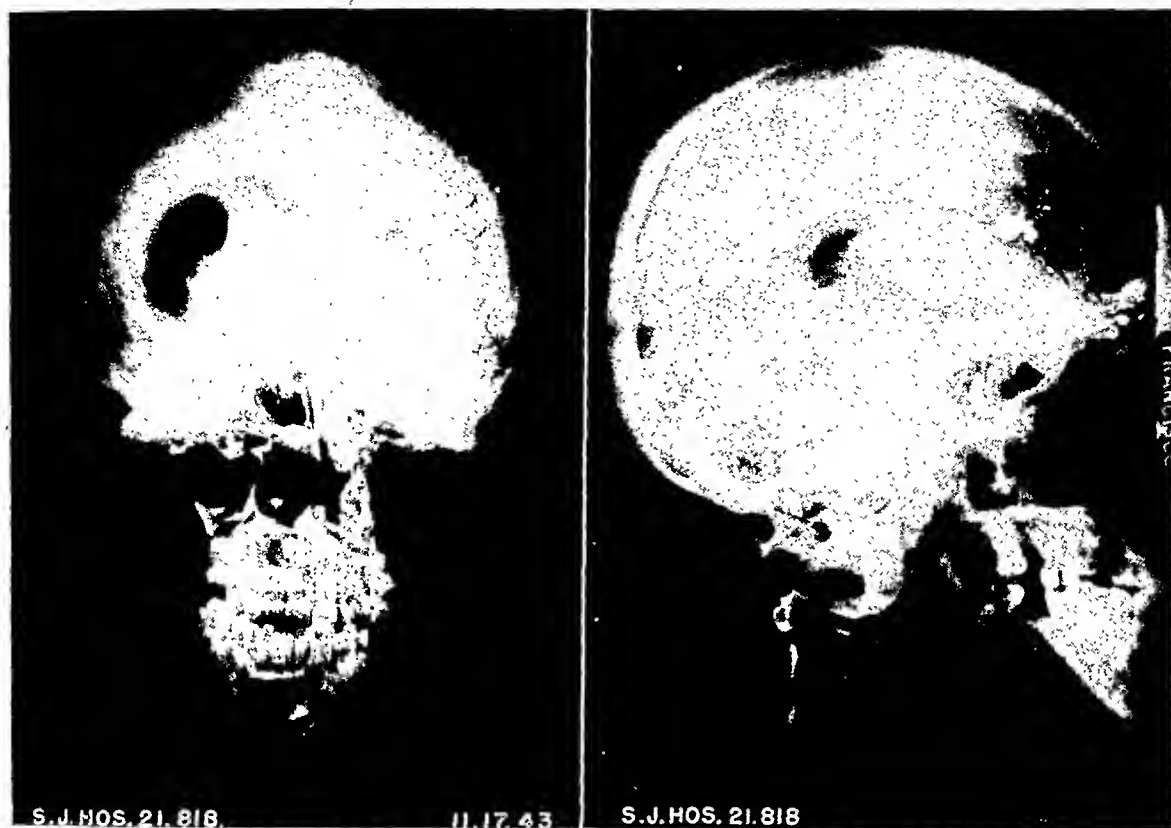


Fig. 2. Roentgenograms made Nov. 17, 1943, nine weeks after injury, showing air in the ventricles, and subdural air in the right frontal region.

neous recovery) presents the "typical" course, if such can be said to occur. After a latent period of nine weeks, the pneumocephalus developed, with an associated rhinorrhea and a recurrence of cerebral symptoms. After a further interval of two weeks the patient recovered.

#### CASE REPORT

On Sept. 10, 1943, the patient, a white male, aged 28, attempted suicide by shooting himself in the right temporal region. There was loss of vision in the right eye, but no other neurological symptoms were observed. The local wound healed by primary intention. The general condition was satisfactory, and three weeks after the injury the patient was dismissed from another hospital with no symptoms except blindness in the right eye. Films at this time showed fractures as described below, and no pneumocephalus.

The patient then entered St. Joseph's Hospital for study in connection with his amaurosis. His general condition was good. There were ecchymosis and edema of the right temporal region with marked hyperesthesia over this area, so that the patient was unable to shave. The right conjunctiva was che-

motie. There was no reaction of the right pupil to light or accommodation, and no light perception. The lower half of the right retina was detached. There were no other subjective or objective findings.

X-ray examination on Oct. 6, 1943, revealed multiple metallic fragments scattered through the frontal lobe along the path of the bullet, with several large fragments under the inner table in the left frontal region. The point of entrance of the bullet was in the right temporal area with a resultant large stellate fracture, showing extension through the floor of the anterior fossa and across the frontal and ethmoidal sinuses. There was a second, smaller, stellate fracture in the left frontal area. No intracranial air was demonstrated (Fig. 1).

The patient was dismissed from the hospital after a few days, and there was no essential change in his condition for several weeks. On Nov. 16, 1943, nine weeks after his injury, he had two severe bouts of headache associated with vomiting. He states that he blew his nose and recovered "a large amount of vomitus." No additional physical findings were demonstrated at this time except for the drainage of watery fluid from the nose for four days—presumably spinal fluid.

X-ray examination showed a large amount of air in both lateral ventricles and some in the third and fourth ventricles. The right lateral ventricle was



as well filled as if pneumography had been performed. There was also a large collection of subdural air in the right frontal area in the region of the fracture through the anterior fossa (Fig. 2).

The patient was placed at bed rest, became comfortable and had no further headaches or vomiting. Skull films ten days after entry showed only a trace of air remaining in the lateral ventricles and no subdural air. There have been no further complaints since discharge, and the patient has returned to work.

#### SUMMARY

A case of traumatic pneumocephalus is reported. It followed a penetrating skull injury associated with fractures through the frontal and ethmoidal sinuses. The methods by which the intracranial air may develop and explanations for the period of delay in the appearance thereof are outlined. The case reported showed spontaneous "cure."

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# Response of the Liver to Irradiation<sup>1</sup>

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ADVANCES in radiological engineering as well as in therapeutic administration—i.e., fractionation and protraction of doses—have enabled the radiologist to deliver increasingly larger amounts of radiation to the organs of the body. While in former decades the response of the skin was the chief concern of the radiologist, more recently the response of the bodily organs has attracted increasing interest.

Perhaps in no field of radiation biology are opinions so greatly divergent as in assessing the response of the liver to irradiation. On the basis of clinical experience, Pack and Livingston (97) classify the liver among the most radiosensitive structures. Jüngling (70), on the other hand, considers the liver relatively radioresistant, and Wintz (126) writes: "According to my experience the radiosensitivity of liver tissue is not very great. It is less than that of the skin and mucous membranes. One may safely expose the liver to a single dose as high as 150 per cent S.E.D. without noticing clinical symptoms indicative of decomposition of liver cells." Desjardins (27) places the liver between skin and muscle in radiosensitivity.

Clinical evidence is available in support of both high and low radiosensitivity of liver tissue. Favoring high radiosensitivity are observations by Beutel (9), Bromeis (15), and Germer and Mellemgaard (52) on increased excretion of urobilin after extensive fluoroscopy during gastro-intestinal examinations. Since experimental studies have revealed the fact that increased urobilinuria is one of the earliest signs of liver damage (Elman and McMaster, 44) and recent observations by Bell (7) have shown that considerable doses of x-rays are delivered to the patient's body during gastro-intestinal fluoroscopy, these clinical observations seem to be

highly significant. On the other hand, the very few reports in the literature indicating serious injury of the liver in patients exposed to extensive x-ray treatment (Mosse, '94; Wetzel, 124; Case and Warthin, 19; Warthin, 121; Palmer and Templeton, 98) seem to support the assumption that the liver can tolerate a considerable amount of radiation without significant damage. It must be taken into consideration, also, that in the reported cases of extensive liver changes following irradiation the organ was already impaired by the basic disease for which radiological treatment was given. It is true that Hall and Whipple (58) in their experiments have not been able to demonstrate an additive effect of chloroform anesthesia and lethal and sublethal doses of x-rays in dogs, but from general pathological observations such an additive effect may safely be assumed. Finally, the well known fact that radiation sickness is more frequent in patients suffering from functional disturbance of the liver (Neuda, 96) supports this point of view.

Since clinical data do not permit a definite opinion concerning the response of the liver to irradiation, an attempt will be made to analyze the results of animal experiments. This analysis will consider the morphologic changes, the histochemical changes, the chemical changes, and the functional changes occurring in the liver after irradiation. On the basis of these data, a quantitative analysis will be attempted. Finally, the mechanism producing these effects will be briefly discussed.

## QUALITATIVE EFFECTS OF IRRADIATION ON THE LIVER

### 1. *Morphologic Changes*

In a recent review of the "Effects of Radiation on Normal Tissues," by Warren

<sup>1</sup> Aided by a grant from Wm. R. Warner & Co., New York, N. Y. Accepted for publication in June 1944.

and his associates (119), the statement is made that "the effects of radiation on the liver should be of unusual interest inasmuch as there are two highly specialized kinds of epithelium besides an important endothelial system and vascular and fibrous elements to compare." Accordingly, the changes in the various tissues of the liver should be considered separately. The difficulties to be encountered in studies along this line are enumerated in Warren's review, and species specificity is mentioned as a major obstacle, as well as the extensive regenerative power of liver tissue and the diversity of irradiation procedures.

Because of Warren's review, the present discussion of morphologic changes may be shortened.<sup>2</sup> As he has pointed out, some investigations (14, 64, 73, 107, 120) have been recorded in which no changes were observed in the liver. These observations belong to the early period of experimental radiology. The negative results are easily explained as due to insufficient irradiation or too short an observation time. Brief mention should be made of the paper by Hall and Whipple (58). These authors stated that they did not find any changes in the parenchymatous organs. Their report cannot, however, be accepted without reservation, since a closer study of their autopsy reports, as pointed out by Case and Warthin (19), reveals some changes in the livers of two dogs.

Changes in the *parenchyma of the liver* have been observed in man (19, 94, 98, 121, 124) and in the following animal species: dogs (3, 12, 29, 50, 58, 91), rabbits (65, 74, 104, 116, 117, 123), cats (50, 65, 104), guinea-pigs (48, 67, 113, 114), rats (21, 82, 100), mice (20, 75, 78, 90), and frogs (115, 118). Hyperemia, hemorrhages, and sometimes necrosis have been the principal observations. "Repair is almost coinci-

dent with injury and proceeds along normal lines" (Warren).<sup>3</sup>

An original procedure has been used by Casati and Cafissi (18) to study the influence of radiation on the liver cells without interference by repair. They exposed livers of freshly killed animals to doses of x-rays of 1,000–2,000 r (100 r per minute) and observed very severe protoplasmic changes. Since "the cell is the site of action of all radiation upon animal human tissues" (39), the effects on the morphology of liver cells merits a more detailed description.

Krause and Ziegler (75) mentioned poorer staining of some parts of the livers of mice exposed to radiation. An excellent description of the cellular changes has been given by Mills (90). Following the application of radium over the anterior abdominal wall in mice, "the earliest definite change noticed occurred about one hour after irradiation. The liver cells . . . were more granular than usual and there were none of the clear glycogen-containing vacuoles which are present in the normal mouse liver." Three hours after exposure, "the protoplasm was deeply granular and the nucleus stained very clearly and was considerably swollen. The latter averaged in diameter fully one-half that of the liver cell, whereas in the normal condition it averages one-fourth to one-third. The whole cell also was slightly increased in size, but not nearly to such an extent as the nucleus." After six hours, "the cells appear more normal. Protoplasm was no longer granular, but the nucleus was still enlarged." After twenty-four hours, "the vast majority of the liver cells appeared normal. There were, however, scattered . . . a few cells which appeared to have degenerated completely." While the liver appeared normal on the third day after irradiation, further changes in liver cells were observed about two weeks after exposure. These cyclic changes in the liver cells after

<sup>2</sup> Consideration of the effects of injected and deposited radioactive substances has been omitted from our review because of the difficulty of estimating to what extent the material deposited in the liver acts as a foreign body and thereby contributes to the histologic changes observed. Pertinent data will be found in the review by Warren (119).

<sup>3</sup> Details concerning the repair process will be found in the papers by Bolliger and Inglis (12), Kolodny (74), Mills (90), Pohle and Bunting (100), and Tsuzuki (117).

irradiation have also been noticed by Pohle and Bunting (100) and by Fischel (48) in rats.

Contrary to the belief of the earlier writers that the first manifestation of liver cell injury is to be found in the nucleus, these investigations point to the cytoplasm as the site of the earliest cell changes. The results of specialized investigations concerning the mitochondria are in agreement with these conclusions drawn from general studies of the cytological changes. Variations in these cytoplasmic structures have been observed in rabbits (93), guinea-pigs (61), and frogs (69, 115, 118). Studies of the mitochondria of frog liver cells have been especially revealing. Wail and Frenkel (118) irradiated frogs with doses ranging from 1/8 to 1 1/2 S.E.D. (factors: 180 kv., 4 ma., 0.5 mm. Cu and 1.0 mm. Al filtration). Four to eight hours after exposure, the rod-shaped mitochondria appeared cigar-shaped and finally changed into granula. The rapidity of these changes was found to increase with increasing doses. Thus, in liver cells morphologic changes in the cytoplasm may precede those in the nucleus.

Changes in the *stroma of the liver* concern chiefly the blood vessels. A detailed description has been given in Warren's review (119).

*Reticulo-endothelial changes* are described in the Kupffer cells. The majority of the reports mentioning Kupffer cells at all do so in connection with their vital staining, which has at times been found to be increased and at other times decreased (8, 17, 22, 23, 26, 57, 65, 55, 74, 105). Since, however, intravital staining of liver cells seems, in the light of recent investigations, to be an expression of functional changes, a more detailed discussion will be given later in considering liver function (p. 244).

Tang (111) observed rarefaction of Kupffer cells in the liver of a rabbit which died on the tenth day after exposure to 500 r from a 7-gm. radium pack. Degeneration of Kupffer cells has been observed in rats by Schwienhorst (106). Windholz (125) described vacuolation of Kupffer cells in

guinea-pigs on the third day after total body irradiation with 600 r (factors: 180 kv., 0.5 mm. Zn filtration). It is noteworthy that at the same time the spleen also exhibited severe changes in the form of a considerable decrease in the number of follicles. Hyperplasia of Kupffer cells has been described by Cald (17) and Callierio (16) in mice, and by Tsuzuki (117) in rabbits.

Changes in the *bile ducts of the liver* have been recorded not only in man (Case and Warthin, 19) but also in various experimental animals. We are in agreement with Friedman (see Warren, 119), that "the type of proliferation of biliary epithelium described fairly frequently in connection with radiation change in the liver suggests a repair reaction . . . rather than one initiated by injury of ducts *per se*."

## 2. *Histochemical Changes*

*Decrease in glycogen* (2, 48, 61, 65, 99, 116, 117) and *increase in sudanophil fat content* (4, 12, 21, 29, 61, 80, 81, 86, 93, 100, 104, 111) following irradiation have been described for all animal species. While the changes in the glycogen content manifest themselves soon after exposure, the changes in the fat content usually appear at a later date.

## 3. *Chemical Changes*

The importance of the histochemical studies is supported by the quantitative chemical analysis of liver tissue from irradiated animals. Rother (103) irradiated guinea-pigs over the liver with 1 S.E.D. (factors: 180 kv., 2 ma., no filter), which was an absolute lethal dose. He found the *glycogen content* of the liver tissue decreased while the blood sugar level remained high. Of great importance is his observation that the perfused livers of irradiated animals did not release sugar. This points to the fact that the release of sugar is a secondary process. It was shown by Rother to depend on the integrity of the autonomic nervous system.

As far as fat is concerned, the investigations deal exclusively with the *content of*

TABLE I: CHANGES IN BLOOD AND LIVER CHOLESTEROL IN MICE AFTER IRRADIATION (LÖW-BEER)

Interval after Exposure	300 r		600 r		1,000 r	
	Blood	Liver	Blood	Liver	Blood	Liver
2 hours	-6.9%	-53%				
4 hours	-23%	-2.9%	-67%	+6%	-19%	-9%
24 hours	-60%	+28%	-43%	+11%	-45%	+38%
48 hours	....	....	..	..	-49%	+38%
5 days	....	....			-24%	+55%
8 days	+3%	+3.5%	-37%	+89%	..	..

cholesterol, which has been found to be increased in rats (46) and mice (84). Of considerable interest are the careful studies made by Löw-Beer (84), who exposed mice to a dose of 300 to 1,000 r (factors: 180 kv., 4 ma.) and compared the cholesterol levels in blood and liver. The figures in Table I are taken from his paper and express the percentage of change in cholesterol based on pre-irradiation levels. These figures not only are interesting, because they confirm fully histochemical studies as to quantitative results and their dependence on the time of observation, but they also seem to throw some light on the origin of the fat which was observed at certain times in irradiated livers.

As an expression of effects on the proteins of liver tissues, *increase in non-protein nitrogen* and *decrease in amino-acids* have been observed in rats and guinea-pigs (62, 63).

Other tissue constituents of which a quantitative analysis has been made are *chlorides*, which have been found to decrease. Beutel and Winter (10) gave doses of 750 to 1,000 r (total body irradiation) to rats (factors: 180 kv., 4 ma., 0.5 mm. Cu and 1.0 mm. Al filter, 40 cm. distance). These animals, whether examined on the first, second, third, fifth, or eighth day after exposure, always showed a decrease in chlorides. Nor did the mode of treatment—whether radiation were given in one session or in divided doses—change the result. From these investigations it would appear that the liver is the only organ which reacts to irradiation with a constant loss of chlorides.

After total body irradiation of rats with

100 to 200 per cent S.E.D. (factors: 170 kv., 0.5 mm. Cu and 2.0 mm. Al filter) increase in oxidized as well as in reduced *glutathione* has been found. No increase was induced by irradiation of livers *in vitro* (Nathanson and Tscherkes, 95).

No significant changes in the *vitamin A* content of guinea-pig livers has been observed (112) within twenty-four hours after local application of 550 r (field 6 × 8 cm., filtration 0.5 mm. Cu and 1.0 mm. Al). Nor was the *vitamin A* content of human livers influenced by irradiation *in vitro* (102). Decrease in *vitamin C* content occurred in the livers of irradiated rats (59).

Irradiation of rat liver *in vitro* led to a decrease in *phosphatase* (87).

#### 4. Functional Changes

From the data reported, it is evident that far-reaching functional changes must take place in the cells of livers of irradiated animals. Experiments with intravital staining especially point to changes in cell permeability. In agreement with these findings are the studies of Mendeléeff (89) on the *electrical cell potential of liver cells of guinea-pigs*. Animals irradiated over the abdomen for ten minutes (factors: 180 kv., 4.0 ma., 0.5 mm. Cu and 1.0 mm. Al filtration, distance 23 cm.) showed no immediate change in electrical cell potential as compared with unirradiated controls. Animals killed nineteen to twenty-four hours following exposure showed a decreased cell potential, but four to five days after exposure no difference between the potentials of liver cells in irradiated and unirradiated guinea-pigs was observed. These findings do not necessarily signify

a functional reaction in a cell, since we were able to demonstrate a similar breakdown of the electrical cell potential and its restoration within a period of days in a non-living model of a cell (collodion membranes) after irradiation (33).

The significance of vital staining has been discussed in detail by Halberstaedter and Wolfsberg (57). Recent studies by Laurens and Graham (77) and Graham (55) have demonstrated that the *increased vital staining capacity of livers* in irradiated dogs can be reversed by the administration of adrenocortical preparations. These observations definitely classify this phenomenon under the heading of vital functions rather than morphologic changes.

As an expression of disturbed cell function Heeren and Pansdorf (63) noticed a *decrease in the oxygen consumption* of irradiated livers from 22.7 c.mm./mg./hr. to 13.1 c.mm./mg./hr. in mice irradiated with 550 r in air over the abdomen. Total body irradiation of rats with 1,500 r (factors: 120 kv., 4 ma., 4 mm. Al filtration) *increased the anaerobic glycolysis* (Druckrey *et al.*, 30). This change in aerobic glycolysis indicates that the metabolism of the irradiated liver cell is similar to that of malignant tumor cells and of various other irradiated tissues (39).

There is *increased enzymatic activity* in the livers of irradiated animals (Abderhalden, 1). Most important is the increased postmortem autolysis (120).

Gross studies to prove disturbance of liver function following irradiation have repeatedly been made and the results are in part negative (Borak and Kriser, 13) and in part positive (Czepa and Höglér, 24). Disturbance of liver function has also frequently been inferred from studies of blood levels of various substances. Since these changes do not depend exclusively on liver function proper and may be subject to extrahepatic radiation effects, their discussion will be omitted.

Detail studies of liver function following irradiation have been reported by various investigators. Thiele and Hartkopf (112) observed *disturbance of the storage capacity*

*of the liver for vitamin A* in guinea-pigs. Furthermore, *disturbances in bile secretion* have been seen. Increased secretion in dogs with bile fistulae has been reported by v. Barbaczy (6). Takeda and Youen (110) observed an increased secretion of bile following small doses of radiation and a decreased flow after larger doses. Inhibition of bile secretion by large doses of radiation was also observed by Smyth and Whipple (108) in dogs. Similar changes have been demonstrated in frogs by intravital microscopy (Hartoch and Israelski, 60).

### 5. Summary

In summarizing the qualitative effects produced in the liver by irradiation of animals, we can establish the following facts:

1. Basically the same effects have been found to occur in all animal species investigated.
2. The observation of these effects depends on:
  - (a) The dose of irradiation: The material presented shows that there exist definite threshold doses for the various cytologic, histochemical, and functional changes.
  - (b) The time of observation: It is evident from the material presented that irradiation produces a chain of reactions in liver tissues. It is, therefore, easy to understand how some authors failed to observe certain phenomena usually forming the last links in this chain, when their observations were made shortly after exposure.
  - (c) The methods of observation: By the use of the most refined and sensitive methods, some effects have been noted immediately after cessation of irradiation. Other procedures have failed to disclose such changes, and some of the apparently contradictory results may be explained on this basis.

3. Roentgen-rays may be classified with the hepato-toxic agents, producing effects similar to those of phosphorus ingestion. This statement is based on the histologic changes, *i. e.*, accumulation of sudanophil fat in the central parts of the liver lobules, accompanied by cloudy swelling, which is considered as "fatty degeneration" (Karsner, 71). Also, the metabolic changes are similar to those usually found in phosphorus poisoning (Sollmann, 109).

#### QUANTITATIVE EFFECTS OF IRRADIATION ON THE LIVER

##### 1. *Approach to the Problem.*

The great variety of procedures used for the experimental study of the effects of radiation on the liver excludes any comparison on the basis of the physical data alone. Even if identical procedures had been employed, a comparison of the effects on animals of different sizes would be futile. It is obvious that the biologic significance of a given dose, *e.g.*, 1,000 r in air, administered to the whole body of a mouse, would be vastly different than that of the same dose administered to a dog.

The problem of the comparison of effects produced by irradiation is essentially a biological one and can be solved only on a biological basis. Thus, the determination of quantitative effects resolves itself into the problem of finding: (a) a readily observable criterion for the radiation effect and (b) a biological common denominator applicable to all animal species.

As a criterion for the estimation of the radiation effect we propose the observation of fatty changes in the liver. This suggestion is made for a number of reasons. (a) As mentioned above, the fatty changes are of special toxicologic significance. (b) The study of the sudanophil fat in microscopic preparations is easy and is facilitated by the fact that in most laboratory animals, under normal conditions, there are only minute amounts of sudanophil fat visible in histologic preparations. We found this true for guinea-pigs, in agree-

ment with Grafflin (53), and we observed similar conditions prevailing in mice. (c) The increased postmortem autolysis found in the livers of irradiated animals (120), which might influence the glycogen content, has no influence on the amount of sudanophil substances. This has been established by us in an investigation in which the livers of guinea-pigs and mice simultaneously irradiated were examined, in one instance after death during the night and in another animal of the same lot ten minutes after death on the following morning. (d) We agree with Grafflin (53) that estimates of fat content from histologic preparations may not represent the true amount of fat present in the livers, but they seem to be superior to similar estimates of histochemically determined glycogen (Grafflin and associates, 54). (e) The procedure suggested takes into account the criticism by Friedman (see Warren, 119) that "the evaluation of minimal or sublethal change is uncertain in cells having as rapid a rate of recovery as liver cells."

As the common biological denominator for the inter-species comparison, the lethal dose of x-rays for the various animal species is suggested. Lethal doses of x-rays have been established by us for various animal species—goldfish, mice, and guinea-pigs (38, 41). Their usefulness has already been proved in various fields of experimental radiation therapy, namely in depth dose determination (Ellinger and Gross, 43) and the study of radiation effects on brain tissue (Ellinger, 42). As a result of these studies, the statement can be made that it is possible to find for any species a dose of x-rays which invariably kills all animals within fourteen days  $\pm 20$  per cent. This dose is considered as 100 per cent lethal, or the absolute lethal dose, ALD (41). In mammals increase of the exposure over this threshold value shortens the period between exposure and death of all the animals. This observation is of importance, since in many instances development of changes produced by irradiation requires a certain amount of time.

TABLE II: COMPARISON OF EFFECTS OF VARIOUS LETHAL DOSES OF X-RAYS ON LIVER AND SPLEEN OF GUINEA-PIGS AT DIFFERENT INTERVALS AFTER EXPOSURE

Doses, r in air	Days after exposure	Liver: Fat Content	Spleen: Malpighian Bodies	Remarks
200	12	None	Decrease in white elements	Repair process
300	12	None	Smaller; much hemosiderin	
300	20	None	Less distinctly outlined. Very little hemosiderin	
400	11	Amount of fats same as in controls, but definite central arrangement	Less distinctly outlined. Much hemosiderin	Repair process
400	12	Definitely increased amount of fat with central arrangement. In one out of three cases there was an enormous amount of fat	Indistinctly outlined bodies. Increase in fibrous tissue	
400	13	Enormous amount of fat with central arrangement	Malpighian bodies hardly recognizable. Considerable increase of fibrous tissue	
400	24	Definite accumulation of fat around the central vessels; amounts corresponding to those of 11th day	Bodies indistinctly outlined	
500	13	Some fat in periphery and around central vessels	Malpighian bodies no longer visible; only a few macrophages left	
600	8	Slight increase in fat around central vessels	None	
600	10	Moderate increase in fat, with definite central arrangement in two instances	None	

Thus, the use of multiples of the ALD often obscures certain observations.

The following are the advantages of the use of the ALD as the common biologic denominator in studies of the quantitative effects of irradiation in different animal species:

1. It makes the study more or less independent of the application of identical physical radiation factors. The description of the clinical course observed in the irradiated animals need only be sufficiently elaborate to permit judgment as to whether or not the dose applied was just sufficient to kill all animals within the prescribed period of time, *i.e.*, 14 days  $\pm$  20 per cent.

2. It permits the inclusion of observations made even in the pioneer days of radiology, when the physical and technical data of exposure were not comparable.

3. It permits the expression of any biologic effect in percentage of the ALD.

## 2. Threshold Dose for Liver Injury

During our previous studies on the lethal dose of x-rays for guinea-pigs, the

occurrence of fatty degeneration of the liver was observed (41). For the purpose of a quantitative study of this phenomenon, the results of histologic studies of the livers of 13 irradiated guinea-pigs have been listed in Table II. The corresponding changes observed in the spleens have been included in this tabulation for reasons which will appear later in this paper. The irradiation factors are the same as in the previous study (41).

As can be seen from Table II, up to a dose of 300 r in air no accumulation of fat was observed in the livers of irradiated animals. On the contrary, the absence of even the small amounts of sudanophil fat encountered in some non-irradiated controls was striking. After the application of 400 r in air, however, increasing amounts of sudanophil fat were observed. This dose kills about 80 per cent of the animals within fourteen days and is, therefore, designated as LD<sup>80</sup> (80 per cent lethal dose) in accordance with the previously adopted designations (41). The LD<sup>80</sup> seems thus to be the threshold dose for the production of fatty degeneration in the



*livers of guinea-pigs.* With higher doses, e.g., 600 r in air, which is 20 per cent more than the ALD (absolute lethal dose), the latent period between exposure and the first fatalities is shortened. The same decreased latent period is seen in the appearance of fat in the livers, as demonstrated in Table II. This observation is supported by the results of a study made by Clarkson and his associates (21). These authors exposed guinea-pigs to a dose of x-rays corresponding to about three times the ALD for this species. All the animals died within five days and showed "advanced" fatty changes in the livers.

Very interesting with regard to the problem of the threshold dose for liver injury are some results obtained by Maruyama (88). He administered to guinea-pigs a daily dose of x-rays which in previous experiments had been found not to produce fatty changes in the livers. This mode of administration caused the death of the animals within ten to thirteen days after exposure. This accumulated dose corresponded to the ALD (absolute lethal dose). In all instances fatty changes were observed. Thus, daily doses of x-rays, individually too small to produce fatty changes in the livers of guinea-pigs, may produce the appearance of sudanophil fat, if given repeatedly over a period sufficient to accumulate a dose equal in effect to an ALD when applied in a single exposure.

As in guinea-pigs, the livers of mice exposed to a dose of x-rays less than LD<sub>50</sub> failed to show even traces of fat. After the application of LD<sub>50</sub> (800 r in air), small amounts of fat were noted between the eighth and tenth days after exposure (41). This fat, however, did not show the definite central arrangement found in the guinea-pigs but was more evenly distributed throughout the lobules. On the fourteenth day after exposure, no sudanophil fat was visible, and for this reason the appearance of the small amounts of fat during the short period between the eighth and tenth days seems to be significant.

The appearance of sudanophil fat in the livers of irradiated mice earlier than

in those of guinea-pigs seems to be noteworthy. This observation parallels that on the latent period between exposure and the first occurrence of fatalities in these two species (41) and apparently is one of the expressions of species specificity in reaction to x-rays. In the case of the liver we are able to support this observation by further data. Wels (122) studied the oxygen consumption of dry liver tissue per cubic millimeter, per hour, for various animal species and found the values to be 10.8 and 4.4 for mice and guinea-pigs, respectively. Thus, the greater metabolic rate in the mouse liver easily explains the earlier appearance of fat. The fact that the changes in mice are, however, less pronounced than in guinea-pigs is remarkable. As a general rule, tissues with a greater metabolic rate are more sensitive to irradiation than those with a slower metabolism (39). Consequently mice, which show the greater metabolic rate, should exhibit the more pronounced changes. That this is not the case seems to point to the fact that the changes observed may not be the direct result of irradiation. This matter will be taken up in detail later in this paper.

The transitory and less striking fatty changes in the livers of irradiated mice probably account for the fact that of all the reports of experiments in which definite lethal dose of x-rays were given to mice, only that of Clarkson and his associates (21) mentions the appearance of fat.

Further quantitative data on the appearance of fatty changes in the liver of irradiated animals can be obtained from the literature. Potter (101) has recently demonstrated that rats invariably die within a week after total body exposure to 800 r in air. He found this to be true for radiations of 100 kv. with 0.25 mm. Cu filtration up to 400 kv. with Thoraeus A filter. These data, even if not completely corresponding to our definition of the ALD, could nevertheless be used as an approximate value for the ALD of x-rays for rats. Clarkson and his co-workers (21) found the threshold dose for the appearance of fat in the liver of rats to be 600 r in air (factors:

150 kv., 4 ma., 0.3 mm. Cu filtration). Unfortunately their paper contains no definite figures for the mortality rate with this dose, but it appears to be about 80 per cent. This would be in agreement with the observations of Potter (101).

Russ and associates (104) found that in cats a dose of x-rays which produced about 70 per cent mortality caused fatty changes in the liver, as did also doses causing the death of all animals within nine days. Under the same conditions of exposure, the changes in rabbits were far less pronounced. This is another interesting example of apparent species specificity in the response of the liver to irradiation, and these observations seem to account for the fact that reports on the effect of irradiation on the livers of rabbits do not mention fatty changes.

In summarizing the material concerning the threshold value for the production of fatty changes in the livers of irradiated animals the following conclusions may be drawn:

1. There seems to exist a definite threshold value for liver injury following total body irradiation.
2. Irrespective of the animal species used, the threshold dose for liver injury, as expressed by the appearance of increased sudanophil fat, seems to be about LD<sup>70</sup> to LD<sup>80</sup> (70 to 80 per cent lethal dose) for the particular species, when the radiation is given in one exposure.
3. Daily application of x-ray doses individually too small to produce fatty changes in the liver may result in such changes if the accumulated dose equals in effect an ALD given in a single exposure.
4. The intensity of these changes and the time of their appearance vary with different species.

### 3. Relationship between Liver Sensitivity to Total Body and to Local Irradiation

It is a well known fact that most organs stand considerably larger doses given locally than as total body irradiation. Pohle and Bunting (100) studied the effects of x-rays on the rat liver after exposure to

2,500 r in air (factors: 140 kv., 0.25 mm. Cu and 1.0 mm. Al filtration, field size over the liver  $2 \times 1.3$  cm.). Sacrificing their animals at various intervals up to 30 days after exposure, they found fatty infiltration with a maximum at about the second day after exposure and recurring at about the eleventh day. As mentioned above, with total body irradiation the threshold dose for the appearance of fatty changes was found to be 600 r in air. The far greater resistance of the liver to local irradiation is thus apparent. In this connection it seems worth mentioning that Bolliger and Inglis (12) applied doses up to 5,900 r in air (180 kv.) to the surgically exposed livers of dogs and were able to observe their animals for periods up to 507 days. From all these observations it becomes evident that factors outside the liver contribute largely to the observed liver changes following irradiation.

### 4. Relative Sensitivity of the Liver to Radiation

For the evaluation of the relative sensitivity of the liver, a comparison of the hepatic changes with those simultaneously occurring in the spleen suggests itself, since in previous investigations (41) it has been demonstrated that the lethal effect of x-rays applied in total body irradiation depends largely on the changes produced in the leukopoietic system, especially the spleen. As indicated by Table II, the sensitivity of liver tissue is somewhat less than that of the spleen.

Another comparison which suggests itself is that between the liver and kidneys, because of the close functional association of these two organs. In various instances where fatty changes in the liver were observed, similar observations were made in the kidneys. This is in agreement with the results of a number of investigators in this field. The conditions, however, seem to be rather involved and will be dealt with in detail at a later date. At this time it need only be stated that the kidneys are apparently more resistant to radiation than the liver. Comparative studies of the

influence of irradiation on the oxygen consumption of liver and kidney tissues point in the same direction. A dose of x-rays which produced a 10 per cent reduction of oxygen consumption in kidney tissue, irradiated *in vitro*, reduced the oxygen consumption of liver tissue 40 per cent under the same experimental conditions (Dognon *et al.*, 28).

### 5. Summary

Evidence presented in this paper shows that in various animal species the LD<sup>80</sup> of x-rays for a particular species, when given to the whole body in one session, produces definite injury to liver cells as indicated by increased amounts of sudanophil fat.

Comparison of the liver changes with simultaneous changes in the spleens of irradiated animals shows that the liver is somewhat less sensitive than the spleen.

The liver, consequently, must be regarded as a radiosensitive organ, as is to be expected from its glandular structure and its high metabolic rate.

### MECHANISM OF THE EFFECT OF RADIATION ON THE LIVER

#### 1. Observations Indicating that Factors Other than the Direct Impact of Radiation Play a Role

Repeatedly during the discussion of the various aspects of the response of the liver to irradiation we have encountered observations which seem to indicate that factors other than the direct impact of the radiation on that organ are responsible for the effects produced.

1. Clinically, Bromeis (15) found increased urobilinuria not only after prolonged gastro-intestinal fluoroscopy but also after extensive chest fluoroscopy.

2. Holtermann (66) observed increased intravital staining of the livers of mice after isolated irradiation of the head.

3. Changes in the glycogen and glutathione content of the liver were not produced by irradiation *in vitro*.

4. Livers of mice, in spite of their higher metabolic rate, showed less pronounced changes than livers of guinea-pigs.

5. The liver tolerates far greater doses applied locally than in total body irradiation.

From the evidence adduced it is apparent that toxic substances formed within the irradiated body seem to play an important role in the development of liver changes produced by irradiation. This contention is supported by the fact that fatty degeneration of the liver has also been produced, in dogs and rabbits, by irradiation with threshold erythema doses of ultraviolet rays over a longer period of time (Kauffmann, 72; Montanari Reggiani, 92). Since ultraviolet radiation penetrates the skin for only about 0.6 mm., any direct action of this type of rays on the liver is excluded. The effectiveness of ultraviolet rays in producing liver changes and other organ effects (Ellinger, 31, 32, 34-37) is largely dependent upon their ability to produce a skin erythema. This phenomenon has been proved to be due to histamine-like substances or even histamine itself (Ellinger, 39). It may, therefore, be assumed that histamine-like substances play some part in producing the changes in the livers of animals after x-ray irradiation.

#### 2. The Histamine Theory of Radiation Effects and Liver Changes

As previously explained (Ellinger, 39), the histamine theory has been proved valuable for the understanding of many of the effects of radiation. Its merits for the proper understanding of the response of the liver to irradiation rest upon the following observations.

1. Injection of histamine into animals is able to produce the same chemical changes in the liver as are observed after irradiation (Feldberg and Schilf, 47).

2. Injection of histamine produces increased bile secretion (Baltacéano and Vasiliu, 5; Feldberg and Schilf, 47), which is observed, also, after the application of smaller doses of x-rays.

3. Chronic injection of histamine produces in dogs the same histologic picture as irradiation, including extensive accumulation of sudanophil fat around the cen-

tral vessels of the lobules (Eppinger and Leuchtenberger, 45; Hueper and Ichniowski, 68).

This short review demonstrates the striking resemblance between the effects of histamine and irradiation on the liver. The assumption that histamine plays an important role in the production of the radiation effects on the liver with respect to function and structure seems well founded. In the light of the histamine theory the following observations are easily understood:

1. The less intensive response of the liver of the mouse to irradiation as compared with the guinea-pig. Mice are about 1,000 times more resistant to histamine than guinea-pigs (Feldberg, 46; Feldberg and Schilf, 47).

2. The species differences observed in the radiation effect on the liver in the cat and the rabbit. While it is true that the resistance of these two animal groups to acute intoxication with histamine is of approximately the same order, the rabbit detoxifies slowly injected histamine more easily than the cat (Feldberg and Schilf, 47, p. 87). The liberation or formation of histamine-like substances during irradiation corresponds to a slow injection, which would explain the less pronounced changes in rabbits.

3. The greater tolerance of the liver to local application of x-rays than to total body irradiation. The greater total irradiated volume would obviously contribute a greater amount of histamine-like substances.<sup>4</sup> Thus the same dose of x-rays distributed over the entire body becomes more toxic so far as the liver is concerned.

4. The observation by Bromeis (15) that extensive fluoroscopy of the thorax produces increased urobilinuria. Pulmonary tissues are among those having the highest content of histamine (Feldberg and Schilf, 47). It may be that some of this is liberated by the doses received during intensive fluoroscopy of the lungs (Bell, 7).

In summary, the histamine theory of radiation effects seems to explain all those observations concerning the response of the liver to irradiation which cannot be explained as effects of the direct impact of the rays.

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# Congenital Solitary Pelvic Ectopic Kidney, with Report of a Case<sup>1</sup>

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A SOLITARY pelvic or ectopic kidney is a rare anomaly if its frequency is to be judged by reported cases. Because the kidney is single, other abnormalities of form, such as a fused kidney, are not included in this classification.

In 1937 Stevens (1) reviewed the literature and tabulated the findings in 27 cases including 2 of his own. He estimated that

pointed out the importance of excretory urography or retrograde pyelography before every kidney operation. Ockerblad's and Carlson's case (3) is interesting because the patient had two uneventful pregnancies and deliveries. In fact, the only time she was free from albuminuria was during these pregnancies. Mayers (4) reported an additional case and proposed a classi-

TABLE I: PUBLISHED CASES OF SINGLE PELVIC KIDNEYS, 1937-1943

Case No.*	Age and Sex	Anomalies	Clinical Diagnosis	Urologic Findings
28 (Houtappel, 1937)	68 M	Mentally defective	Anuria due to bilateral ureteral calculus	Right ureteral orifice only. Single pelvic kidney with stone in the calix
29 (Ockerblad and Carlson, 1940)	36 F	Left tube and ovary absent	Solitary pelvic ectopic kidney	Right ureteral orifice only. Kidney weighed 40 gm.
30 (Mayers, 1940)	33 M	No abnormalities	Solitary pelvic ectopic kidney	Left half of trigone absent. No left ureteral orifice. Right ureteral orifice involved with small ureterocele
31 (Ogden and Maltry, 1940)	17 F	Absence of vagina, uterus, tubes, and appendix. Ovaries and sigmoid displaced	Pelvic mass assumed to be uterus	Left ureteral orifice only. Kidney overlying sacrum. Renal pelvis slightly dilated
32 (Planas and Fablet, 1940)	31 F	No abnormalities	Uterine fibroid	Excretory urogram and pyelogram show a solitary pelvic ectopic left kidney. Absence of right ureteral orifice
33 (Nichols and Marr, 1945)	20 F	Uterus and tubes absent. Ovaries not identified	Pelvic kidney thought to be uterus	Excretory urogram postoperatively showed ectopic kidney of normal size

\* Twenty-seven cases seen up to 1937 were tabulated by Stevens (1).

a single pelvic kidney occurred once in every 22,000 births. He also stressed the importance of urologic management of such cases and the frequent association with genital anomalies in women.

Details of the cases reported since Stevens' publication are presented in Table I. Houtappel's (2) patient was sixty-eight years old. The oldest patient reported previously was forty-eight; the average age was sixteen. Houtappel

classification for renal anomalies. He also suggested that the designation "congenital solitary pelvic renal ectopia" be substituted for "pelvic single kidney." Ogden and Maltry (5) added another case, briefly reviewed the embryology of the kidney, and presented an explanation for unilateral renal agenesis. Planas and Fablet's patient (6) had one delivery which required the aid of forceps and a second which was normal.

<sup>1</sup>Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.





Fig 1. Congenital solitary pelvic ectopic kidney.

#### CASE REPORT

A woman, aged twenty, came to the Cleveland Clinic in October 1939 because she had never menstruated. She had been happily married for three years. She had no symptoms referable to the urinary tract and felt perfectly well generally. Four sisters were normal.

Examination showed a well developed, well nourished woman. The breasts were about average for a young adult female. The external genitalia were normal. The vagina admitted two fingers and appeared normal except that it was somewhat short and that no cervix could be palpated. On rectal examination a mass was felt, extending from the upper left to the lower right posterior pelvis and tapering to a small point at the lower end. The examiner thought that this might be the uterus and decided to do an exploratory laparotomy. If the mass were found to include the uterus and cervix, he was prepared to consider the possibility of connecting them to the vagina.

On five urinalyses the specific gravity of the urine ranged from 1.020 to 1.032, and the pH from 5.0 to 7.5. Results of tests for sugar were negative. A trace of albumin was found twice, a few granular casts once, and an occasional red blood cell three times. The blood urea was 45 mg. per 100 c.c. The kidneys were obscured on a roentgenogram of the kidney, ureter, and bladder region.

In January 1942 the patient was admitted to the Cleveland Clinic Hospital for operation. A lower abdominal midline incision was made, and in the hollow of the sacrum a kidney of normal size was found, whose pedicle extended upward along the

left side of the vertebral column toward the normal point of exit of the renal vessels. No kidneys could be palpated in the normal kidney area. The upper end of the vagina, which had been packed with gauze preoperatively, could be seen. No uterus, tubes, or ovaries were present in the pelvis. The incision was closed, and the postoperative course was uneventful.

On the eleventh postoperative day an excretory urogram was done. There was no evidence of a kidney on the left. The right kidney was in the pelvis—a congenital solitary pelvic kidney (Fig. 1).

This case illustrates the necessity for an excretory urogram in the presence of a suspicious mass in the pelvis and anomalous development or absence of the uterus, tubes, or ovaries, or when a kidney is not demonstrable roentgenographically.

#### DISCUSSION

The earliest recognition of this anomaly was in an eight-month fetus. This was the first case to appear in the literature, being reported in 1830. A number of examples were discovered at autopsy. Kidney stones were found in 4 cases. In 2 instances the solitary kidney was removed as a tumor. A nephrostomy was performed in 1 case, and a lithotomy in 2 cases. All were successful operations.

The reproductive and excretory systems are closely related in their development. Both originate in the mesoderm. At an early embryonic age the dorsal surface of the mesoderm thickens and forms the wolffian ridge. From the principal portion of this ridge the primary excretory organs develop. On the mesial side, however, a second ridge appears, known as the genital ridge, from which the ovaries and testes develop.

Excretory organs develop in three distinct stages. The pronephros is only a temporary development except for the duct, which becomes the wolffian duct and develops into primary renal pelvis and the ureter. The second primary development is the mesonephros, or the wolffian body. The third and final stage is the metanephros, which is associated with the development of the reproductive organs.

From the genital ridge the müllerian

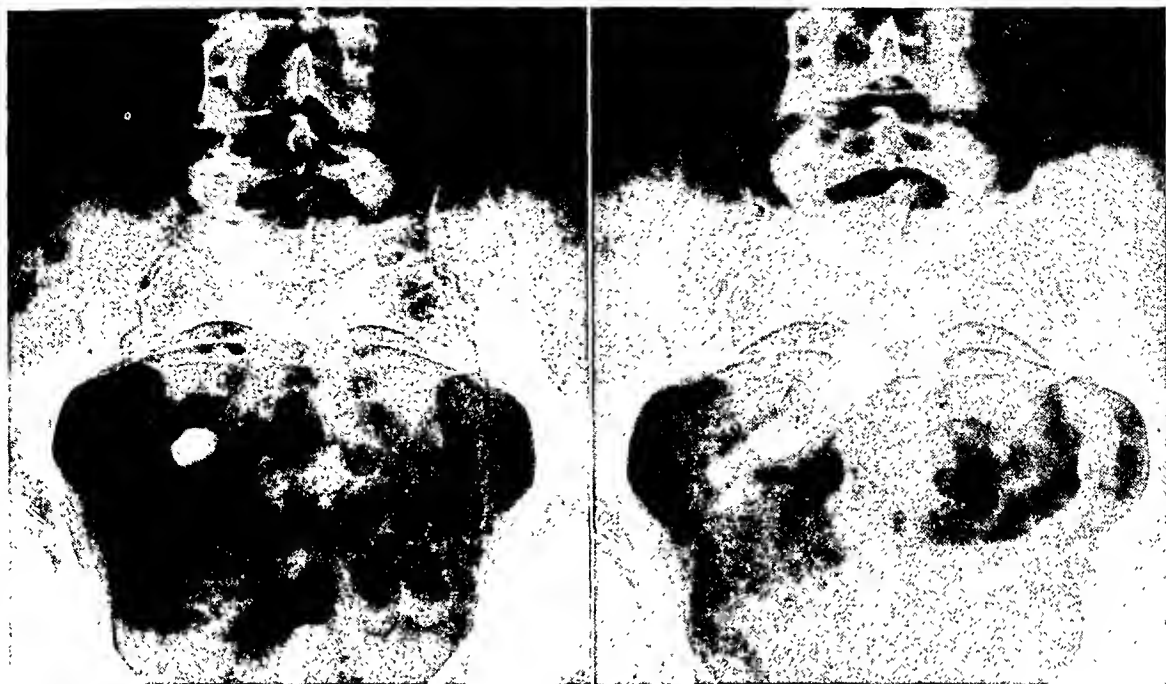


Fig. 2 (left). Roentgenogram showing calculus in lower ureteral area.  
 Fig. 3 (right). Urogram showing the calculus shown in Fig. 2 to be in a pelvic kidney.

ducts develop. These ducts make contact and finally fuse to form the uterovaginal canal.

The metanephros is the permanent kidney and appears about the fourth week of embryonic life. The ureter develops from the wolffian duct. At first this is a tubular bud, but it grows upward and divides to form the major calices, which also divide to form the minor calices. It is evident from the embryologic picture that congenital variations in the reproductive and excretory organs are a likely possibility.

From their inception, the kidneys are separate organs. Consequently, one kidney may be definitely anomalous or remain in a pelvic position, while the opposite kidney is normal. On the other hand, one kidney may be entirely absent, while the remaining one is anomalous. The kidneys begin their ascent and rotation early in embryonic life and usually reach their final position and proper rotation at the end of the ninth week. It is believed that the permanent renal vessels develop and are united with the kidney at this time.

It was formerly believed that the kidney was supplied by vessels along its course of ascent and that such vessels sometimes became fixed and accounted for the position of a pelvic or ectopic kidney. This is probably fallacious, even though the blood supply to an ectopic kidney sometimes comes from the bifurcation of the aorta in the lower abdomen. The subsequent development of the ureter is continuous during the period of normal growth. The kidney actually rises but a very short distance in the embryo, and further migration is simply a matter of general body growth. The ureter grows sufficiently in length to reach the kidney in its final position.

One may then conclude that absence of one kidney may be due to complete failure of the ureteral bud to develop or to early degeneration of the ureteral bud. In most instances the anomaly will be accompanied by absence of the corresponding ureter and also of the ureteral orifice in the bladder. As the rotation of the kidney on its long axis occurs during its ascent in early embryonic development, the ectopic or pelvic kidney usually shows no rotation.

The pelvis lies anteriorly or medially and on the pyelogram or urogram is usually observed as a bizarre kidney pelvis. That the ureter of the pelvic kidney is usually only long enough to drain the kidney is frequently an important fact in differentiating a ptosis of a normal kidney and an ectopic pelvic kidney.

There is always the possibility of mistaking a pelvic kidney for a tumor. One of our patients had two exploratory operations in an attempt to remove a supposed ureteral calculus. The notes of the second operation stated that a mass was found in the pelvis and that the calcification was evidently in this tumor (Figs. 2 and 3). The excretory urogram, however, showed the mass to be an ectopic kidney with a stone.

We wish to emphasize the danger of removing a solitary pelvic kidney erroneously diagnosed as a tumor. Before operation is undertaken, an excretory urogram

or cystoscopic examination, with a pyelogram, is extremely important in all cases of congenital anomalies of the reproductive organs in the female, atypical masses in the pelvis, or low-lying calculi when there is no history of symptoms indicating passage down the ureter.

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# High-Altitude Joint Pains (Bends): Their Roentgenographic Aspects<sup>1</sup>

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IN DEEP-SEA diving the respiratory gases are forced into solution in the body fluids and tissues as a result of increased pressure. When return to the surface is fairly rapid, these gases are present in a supersaturated state, and bubbles frequently form. Extremely small at first, these go through a period of expansion, followed by gradual absorption. Nitrogen gas, being physiologically inert, is most important in causing these bubbles; its inertness results in their slow absorption. Ascent to altitudes of 25,000 feet or higher in aircraft results in a similar supersaturation of dissolved gases, with a tendency to bubble formation. The intense pain of "caisson disease," commonly spoken of as diver's "bends," has its counterpart in aviator's "bends," resulting from exposure to extremely high altitude. The symptoms can readily be elicited by simulated flight in an altitude chamber. Ordinarily the pain disappears at about 25,000 feet during the return to ground-level pressure. It is thought that the "bends" pains are due to expanded extravascular bubbles, as a direct or indirect pressure effect. It has also been suggested that intravascular bubbles may, through ischemia, stimulate the pains of "bends." Symptoms are more frequent and more severe if exercise is engaged in at the high altitude. They are most commonly referred to the joints (1).

With the intent to clarify the etiology of aviator's "bends," we have made a roentgen study of the affected parts in a decompression chamber at altitudes of 35,000 and 38,000 feet, both in the presence and absence of pain. As our work progressed, we learned of work being done

by others in the same field and have received many helpful ideas from them.

The first reported roentgen observation of gas in the tissues in "bends" seems to have been by Gordon and Heacock in 1940 (2). A patient who had been working under pressure (25 lb. per sq. inch) suffered fracture of the proximal ends of the tibiae and was "decompressed" rapidly. Study of the published reproductions of the roentgenograms suggests that the authors may have been misled by a lipohemarthrosis. This is not an uncommon occurrence after fracture at this site, and a layer of fat floating on top of blood in the synovial cavity can indeed imitate a bubble of gas.

## METHODS

In our studies lateral views of knees were made on non-screen film with a small portable x-ray machine. Often pain was present in only one knee, but films of both knees were made (routinely) for control. Similar films were also made of the subjects at sea level. No extensive studies of the chest or abdomen were attempted.

## RESULTS

In every person, whether with or without "bends" pain, gas can be shown in the knee joint at an altitude of about 20,000 feet, increasing to a maximum in about thirty minutes at 30,000 feet.

The demonstration of large volumes of gas (estimated at 50 to 75 c.c.) is clearly seen in Figure 1. Gas in the knee joint, however, is not necessarily associated with pain and may be freely aspirated. It consists of nitrogen, oxygen, and carbon dioxide, approximately in equilibrium with the normal blood gases. It appears also in

<sup>1</sup>From the Aero Medical Unit, University of California, Berkeley, Calif. The work described in this report was done under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of California, Berkeley, Calif., under the direction of Dr. J. H. Lawrence. Accepted for publication in November 1944.



Fig. 1. Large collection of gas in the synovial space of the knee; more specifically, the suprapatellar bursa. This subject had been at an altitude of 38,000 feet for twenty-eight minutes and had no bends or pain.

periarticular tissues: (a) in small irregular collections, (b) in small discrete bubbles, (c) in streaks along fascial planes and tendons.

#### CONTROLLED EXPERIMENT

These studies were carried out at 35,000 feet altitude, which was attained at a rate of 5,000 feet per minute. Exercise, consisting of five squats to the "heel-sitting" position, was done every three minutes to increase the speed of appearance of pain in the knee. Films were made only on subjects with knee pain of moderate or greater severity. Films were made of the knee without pain for control purposes.

Most of the films were interpreted twice. A count was made of the number of bubbles that were discrete and found posterior to the femur in the upper popliteal fossa (Fig. 2). The amount of streaking was estimated on a 0 to 3 scale.

Thirty-five observations were made on

27 individual subjects, with the following results:

1. Bubbles with pain, 46; bubbles without pain, 28. Critical ratio 2.4 (barely significant).
2. Streaking with pain, 47; streaking without pain, 15. Critical ratio 3.71 (highly significant).

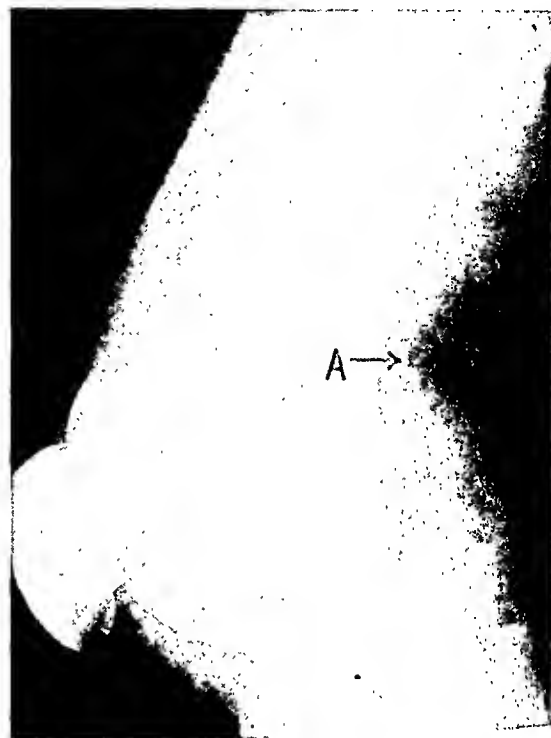


Fig. 2. A collection of discrete and irregular bubbles (A) is seen posterior to the distal end of the shaft of the femur. Note also the wavy streak of gas which undoubtedly lies in a fascial plane or along a tendon (B). This subject had moderately severe bends. He had been at 35,000 feet for ten minutes, having done three series of deep-knee bending.

3. Total tissue gas (bubbles plus streaking) with pain, 63; without pain, 43. Critical ratio 3.3 (significant).

The critical ratio is a measure of the statistical dependability of a difference, and is defined as the mean difference divided by the standard error of the mean difference. For 27 individuals, a critical ratio of 2.1 is possibly significant, while a ratio of 2.8 or greater is definitely significant.

The results of this analysis indicate that the greater the amount of bubbles or streaking seen in the periarticular tissues, the more likely is "bends" pain to occur.

Both bubbles and streaking may occur in the absence of pain. To our knowledge there is no characteristic roentgenographic picture with which the pain is correlated.

The gas is usually reabsorbed from the soft tissues and joint spaces by the time sea level is reached, although we have seen small (2 mm.) bubbles persist in a few in-



Fig. 3. Collection of gas in the vaginal sheath of the flexor tendon. This was easily palpable and could be milked along the length of the finger. No pain was experienced.

stances for as long as five minutes after return to sea level.

We have not been able to demonstrate free gas in the subarachnoid or subdural spaces at altitude in the presence of pain (2 subjects), even though gas bubbles have been demonstrated in the spinal fluid of animals by Haldane *et al.* (3).



Fig. 4. An example of various foci of gas formation in the wrist, indicated by arrows. This subject had no pain.

Free gas could not be shown in the peritoneal or pleural spaces (3 subjects).

#### SUMMARY

1. Demonstrable gas is present in the soft tissues and synovial spaces when the body is subjected to decompression, although pain may be absent.

2. Bends pain is more likely to occur when the quantity of periarticular gas is greatest, but no characteristic pattern of gas formation has been recognized in bends.

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# A Contribution to the Treatment of Post-Irradiation Necrosis<sup>1</sup>

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THE MANAGEMENT of post-irradiation ulcers is one of the most perplexing problems confronting radiotherapists and dermatologists. Such lesions are usually punched-out ulcers, the walls of which are composed of thick ischemic fibrous tissue. The ulceration itself represents the area of greatest ischemia. Local vascularity is at a minimum, the blood vessels showing marked sclerosis of the intimal, medial, and muscular coats. These tissues, then, are deprived of their normal capacity for growth and repair and therein lies the difficulty of accomplishing the healing of such lesions.

Numerous conservative, non-surgical methods of treating post-irradiation ulcerations have been tried. Among the agents employed are ultraviolet radiation (1), the aloe vera leaf (2), ointment containing pancreatic ferments (3), radium, and an assortment of salves. The results of treatment with these non-surgical methods have not been satisfactory. Conway (4) concludes that conservative measures are of little value in the eradication of necroses following roentgen and radium therapy and that these lesions must be treated by surgical intervention. Surgery, however, must be radical and is often attended by poor cosmetic results. Moreover, not every patient will consent to operation.

In view of these circumstances, the virtues of any other proposed conservative method of treatment should be carefully appraised. Sellers (5) recently reported three cases of "x-ray burns" in which local application of estrogenic hormone in oil yielded excellent results. One of the patients was the author himself. He and one of his patients—both with ulcers of the fingers following overexposure to roentgen rays—had undergone the full gamut of

ointment applications, "with but slight avail." After ten months of unsuccessful treatment, estrogenic hormone in oil solution was applied to the crater of the ulcerations three to six times a day. Improvement was noticeable within fifteen days. Subsequently, sesame oil was used as a control without visible results. Finally, after thirty days of continuous application of estrogenic hormone, the lesions healed. In the third patient, with a roentgen-ray ulcer of the left index finger, treatment with estrogenic hormone for two months resulted in complete healing.

Another favorable report along these lines is that of Wagner (6). He treated 7 patients with roentgen-ray ulcers—3 men ranging in age between thirty-five and seventy and 4 women between forty-four and seventy years of age—with an ointment containing synthetic estrogen, applying this locally every day to the resistant lesions. This therapy resulted in 2 cures, while 5 patients were greatly improved. Wagner observed formation of granulation tissue and beginning epithelization under the influence of the hormone ointment.

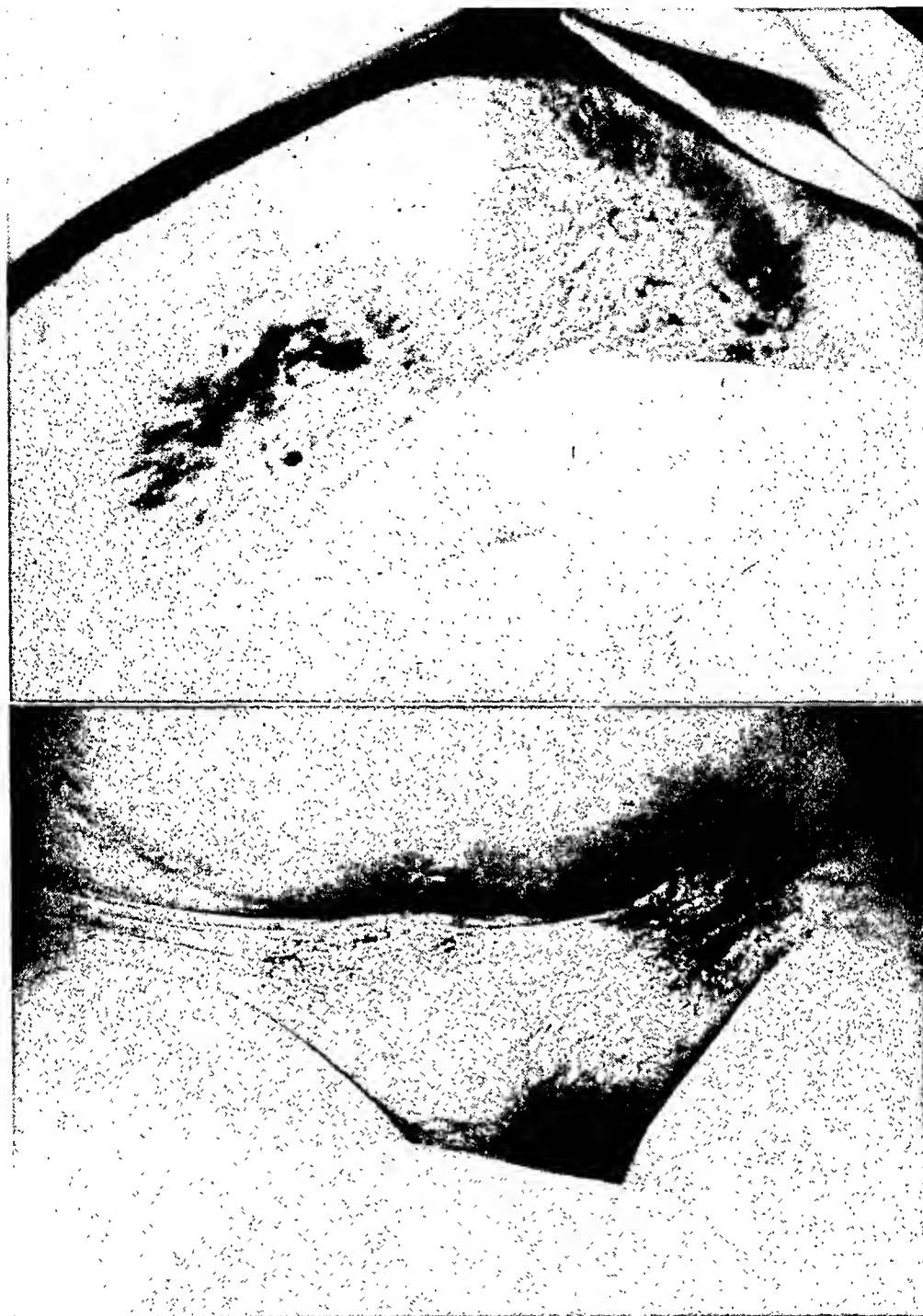
Encouraged by these reports, particularly the article by Sellers, we decided to place on estrogenic therapy two cases of severe post-irradiation necrosis which were under our care.

CASE I: J. S., a white female, aged 43 years, was referred to us for radiation therapy of a carcinoma of the cervix. Between Oct. 7 and Dec. 7, 1937, she received a total of 3,000 r to each of four pelvic areas, anterior and posterior, right and left. On Dec. 9, 1937, radium was inserted in the cervical canal in a sound containing three 10-mg. tubes; in addition, a colpostat containing three 15-mg. tubes was placed in the vagina adjacent to the cervix. A total of 7,000 mg. hours was applied. In February 1938 each pelvic area was given another 1,000 r.

When the patient was next seen, in December 1939, some telangiectasis had developed over both

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Figs. 1 and 2. Case I. Figure 1 (above) shows post-irradiation lesions on both sides of the lower abdomen. On the left side there is severe telangiectasia; on the right side, a deep ulceration measuring  $6.5 \times 7.0$  cm.

Figure 2 (below) shows unchanged telangiectasia on the untreated left side and completely healed ulcer on the right side following application of estrogenic ointment.

lower abdominal areas, progressing by March 1940 to severe telangiectasia with thickening. In December 1942 the patient noticed a painful ulceration on the right side, in the center of the telangiectatic

area. In January 1943 she reported to the clinic, and at that time a deep ulceration, measuring  $6.5 \times 7.0$  cm., was present in the right lower quadrant of the abdomen. The edges of the necrotic area were





Figs. 3 and 4. Case II. Deep post-irradiation ulcer below angle of jaw (left), with complete healing following therapy with estrogenic ointment (right).

sharp and indurated, the skin was thick, and there was severe telangiectasia of the surrounding skin. On the left side there was no ulcer but telangiectasia was severe; the skin was appreciably thickened and board-like (Fig. 1).

A biopsy specimen taken from the edges of the ulcer did not reveal malignant growth. Surgery was advised but was refused. Therefore, on Feb. 2, 1943, treatment with estrogenic ointment was instituted. An amount representing the equivalent of 5,000 I.U. of estrone was applied to the ulcer, no therapy being given to the unulcerated left side. The lesion was then covered with a gauze dressing which had been coated with vaseline to prevent absorption of the estrogenic ointment by the dressing. This procedure was repeated twice a week for one month. At the end of this period the ulcer showed some filling in from below but its width and length were unchanged. It was therefore decided to increase the dose of the estrogenic hormone. The patient was instructed to apply the ointment herself every day (5,000 I.U.) and to report at the clinic twice a week. The "dosules"—individual dose containers—assured exactness of dosage. This technic resulted in steady improvement, and on June 1, 1943, the lesion was completely healed (Fig. 2). On the left side, which had received no therapy, there was no change in the telangiectatic area.

CASE II: J. F., a white male, aged 67 years, was admitted to our clinic in May 1940 with a squamous-

cell epithelioma of the tongue with cervical metastases. Between July 19 and Aug. 2, 1940, he received 1,350 r to the right side of the neck, including a palpable submaxillary node, and 1,350 r to the left side of the neck, which also included a metastatic submaxillary node. On Aug. 8, radium in the form of four 60-mm. 2-mg. needles was inserted in the cervical nodes on each side and sixteen 2 mg.-needles were inserted into the tongue lesion. Each side of the neck received a total of 1,152 mg. hours and the tongue received a total of 3,072 mg. hours. The node in the left side of the neck slowly disappeared but the right submaxillary node failed to show much response. On Dec. 5, 1940, another eight 60-mm. 3-mg. needles were inserted on this side, for a total of 2,184 mg. hours. Thus, the right side of the neck received a total of 3,336 mg. hours of radium.

In July 1942, the patient presented a deep ulcer just below the angle of the right jaw. The surrounding skin was extensively telangiectatic and thickened. The ulcer was punched-out in appearance, with thick indurated walls. It had the shape of a triangle, each side measuring approximately 1.5 cm., and was fixed to the underlying tissues. There was a yellow slough in the crater (Fig. 3). A biopsy specimen taken from the edge of the ulcer did not reveal malignant tissue. The lesion was treated with an assortment of ointments until Jan. 4, 1943, when it was decided to institute treatment with estrogenic ointment. An amount representing the

equivalent of 5,000 I.U. of estrone was applied daily to the lesion and a protective coating of vaseline gauze dressing was placed over the ointment. The ulcer began to fill in from the bottom two months after initiation of treatment and by Aug. 30, 1943, was completely healed (Fig. 4).

#### DISCUSSION

The factors probably accounting for the gratifying results attending the use of estrogenic ointment in these two cases of post-irradiation necrosis are the vasodilating effect of follicular hormone upon the smallest blood vessels of the skin and its selective growth-promoting action.

Experimenting in normal adult males, S. R. M. Reynolds and F. I. Foster (7) studied the peripheral vascular effect of estrogens. Two-thirds of their 20 subjects showed an increase in finger volume following administration of a preparation in which estrone predominated (two of the men were treated with a stilbestrol preparation instead). This volume increase, lasting from half an hour to an hour, is dependent on dilatation of the small vessels of the skin beyond the arterioles. The same authors (8) found that estrogens will dilate the smallest blood vessels of the rabbit's ear. Reynolds and Foster with their associates (9) also measured the dermovascular effects of estrogen on women in the menopause. The response, characterized by an increase in finger volume, is held to be the result of vasodilatation of the smallest vessels distal to the arterioles.

Impaired circulation is one of the etiologic factors in failure of a chronic ulcer to heal. Thus, by exerting a vasodilative effect on the small vessels of the tissues surrounding the lesion, estrogens enhance the blood supply of the adjacent parts with ensuing acceleration of the repair process.

Another salutary effect of estrogen may lie in its potential growth-promoting effect on granulation and epithelial tissue. It has long been known that estrogens are, in a way, growth substances, affecting, for example, uterus, vagina, fallopian tubes, external genitalia, and breasts. The hormone not only promotes the growth of

these organs but also causes changes in the epithelium of the vagina, cervix, and uterus. The application of the estrogenic hormone in gonorrheal vaginitis in children, in senile vaginitis, and in vaginal hypoplasia is predicated on its induction of cellular proliferation. The rationale for estrogen administration in ulcerative cervicitis is the same. While it is not within the scope of this presentation to prove the induction of such cellular proliferation by estrogen in the ulcer cases reported, the possibility of such an action outside of the reproductive tract should be kept in mind.

#### SUMMARY

Two severe cases of post-irradiation necrosis are presented, in which the application of an estrogenic ointment brought about complete healing of the ulcers. A possible rationale for such therapy is briefly discussed.

**ACKNOWLEDGMENT:** The estrogenic ointment used in this study was Menformon Dosules generously supplied by Roche-Organon, Inc., Nutley, N. J., through the courtesy of Dr. Leo Pirk.

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# Radiology vs. the Monsoon: Effect of Climate upon Equipment<sup>1</sup>

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THE PRESENT communication is intended for those who are interested in the physical and technical aspects of radiology. Radiologists whose concern in their specialty is purely medical need read no further, for it is our purpose to discuss the behavior of x-ray equipment exposed to unusual climatic conditions.

Before presenting our experiences, it seems fair to state that the apparatus used in our department was not meant for operation in a monsoon area alone. The global aspects of World War II made it necessary to employ the same equipment under climatic conditions of all sorts. Nevertheless, these machines have given excellent service no matter where used.

The wide variations in the humidity and temperature in India produced defects and failures in our equipment which we believe are worth recording. Whereas none of these "breakdowns" was considered a major problem, they did cause trouble and had to be recognized and rectified. It is with the hope that our experiences may help others working in a similar climate that these difficulties have been reviewed and are presented here.

The yearly rainfall in that part of India in which our hospital was located averaged about 120 inches. Most of this precipitation occurred during June, July, August, and September, when the monsoon was at its height. April, May, and October were also wet but with much longer rain-free intervals.

The humidity varied between 85 and 100 per cent during the monsoon. Whereas during the rest of the year the figure was not so high, it frequently remained above 80 per cent. During November, December, January, and February, at about five o'clock in the afternoon a heavy fog settled over the valley in which we were situated and did not lift until eight o'clock the next

morning. During these months, however, the middle of the day was usually dry. The temperature in the shade varied from a low of about 55° during the winter months to about 95° during the monsoon.

In summary, the weather in the environs of our hospital was damp or wet most of the time, uncomfortably hot about half of the time, and very dry about one-quarter of the time.

## EFFECT UPON X-RAY FILM

While we were aware of the untoward effects of heat and humidity upon unexposed x-ray films, we were surprised to find serious fogging of untropically packed films six to nine months before the film expiration date was reached. This was not true of tropically packed film, which in most instances remained in excellent condition. But, whereas films thus packed in metal containers remained in better condition than those delivered in paraffin-soaked cardboard boxes, we felt that the added expense<sup>2</sup> of the metal containers used for tropical packing was not justified if the films were to be used before the expiration date and the cardboard boxes were not damaged. When tropically packed films manufactured by the same company were examined at the end of the same expiration period, little gross difference was observed between the quality of those packed in metal containers and those sealed in paraffin. On the other hand, considerable difference existed between tropically packed films prepared by different companies. Indeed, the film of some manufacturers could not be used even though it had been tropically packed and the expiration date was not exceeded.

An extremely common nuisance in various localities in India was mold (Fig. 1). Unless precautions were taken, photographic and x-ray films were rapidly

<sup>1</sup> Accepted for publication in June 1944.

<sup>2</sup> We assumed that the metal containers were more expensive although we were unable to obtain price comparisons.

covered with its seum-like patches. It developed much more commonly after the films had been exposed and processed, probably due to removal of the protective wrapping material. The mold appeared as irregularly shaped gray or greenish patches which spread rapidly across the surface of the film, disfiguring it within a few days. Whereas rapid drying and the use of some type of container in which the films could be enclosed delayed the process for weeks, within several months the mold frequently began to develop around the edges of the film.

Various procedures have been advised to prevent film from becoming moldy. We found it most expedient to use a solution of 5 per cent formaldehyde in which the completely processed film was immersed for one minute, after which it was allowed to dry slowly in the air. The film thus partially dried was then *completely dried* in the regular army field dryer, a procedure which we believe was of paramount importance in preventing mold. Ordinary care was observed at all times to keep dirt from settling upon the films until they were stored. While not 100 per cent effective, these precautions prevented the growth of mold almost entirely.

#### FILM PROCESSING

When the Radiological Department first began to operate, freshly prepared developing and fixing solutions ready for use were available. When these chemicals became exhausted, a new stock was prepared with tap water, as there was no distilled water available for making solutions. The solutions were prepared in enamelware buckets at proper temperature by a technician who had specialized in film processing in civilian life. The chemicals dissolved completely and the solutions were allowed to stand twenty-four hours before use.

When adequately exposed films were processed in these freshly made solutions, the images were barely perceptible. It was obvious that something was wrong with the developing solution. A second



Fig. 1. Mold on a roentgenogram. This film, about nine months old, was not immersed in 5 per cent formaldehyde when processed. The mold colonies are represented by the small gray patches.

container of developer was then prepared, with the same water, with the same result. The image was barely distinguishable after the film had been fixed. Apparently the reducing agents in the developer were exhausted by some substance in the water. It was believed that the chlorine used in the hospital water supply was to blame.

Since we had no distilled water and no facilities for collecting rain water, river water was obtained, which was boiled and filtered. The developing solution made from this water was also exhausted before it was used.

A third water supply was then tapped, a well at some distance from the hospital. The solutions made with this water behaved normally, and we continued to use it until the hospital water supply was changed, following which we encountered no difficulty with our solutions even though chlorine was still used.

The indications were that the original water supply contained enough organic and inorganic waste to exhaust the reducing



Fig. 2. Fixing solution scum, scraped from the top of a freshly made 10-gallon container of fixing solution. It had the consistency and color of chocolate ice cream. It represented about 6 ounces of debris.

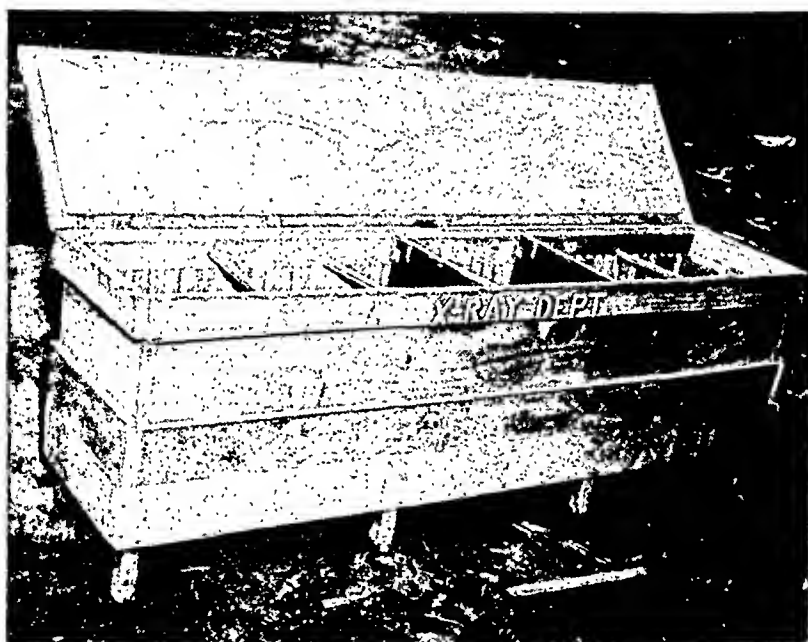


Fig. 3. Cassette storage bin made of wood, with two 25-watt bulbs in the bottom. Note slots for 14 X 17-inch cassettes within the box. Smaller cassettes and fluoroscopic screens were stored in a second bin of similar construction.

ing properties of the elon and hydroquinone contained in the developer. This water was drawn from a river swollen by the monsoon and extremely turbid, in which dead animals could be seen floating constantly. Whereas the new water supply to the hospital came from the same source and contained chlorine, we had no

further difficulty with processing solutions, probably as a result of the filtration and the addition of settling tanks to the water system.

In spite of filtration and settling tanks, however, enough silt still remained in the water to clog surface drains and collect as a sediment in the processing tanks. In pre-

paring fixing solutions the silt formed a mud-like scum on the surface, which had to be carefully removed (Fig. 2). Unless this was done, the silt was deposited upon the film in appreciable quantities. The dirt in the developing solution settled to the bottom of the container, from which it was scraped and washed whenever new developer was prepared.

Constant vigilance was necessary to prevent sweat from marring films and cassette screens. Perspiration from the hands and forearms was particularly difficult to control. Once dropped upon screen or film emulsion, its imprint could not be entirely eradicated. The most serious damage occurred in cassettes, where moisture made the film emulsion stick to the emulsion of the screen. This frequently resulted in permanent scarring of the screen emulsion. To prevent this, our technicians were trained to open cassettes just a few inches, thereby minimizing screen damage while removing films and reloading cassettes.

#### CASSETTES

Standard bakelite-faced cassettes of the type seen in the United States were used during the past year. Whereas little difficulty in maintaining good screen contact was experienced in the  $8 \times 10$ - and  $10 \times 12$ -inch cassettes, the  $14 \times 17$ -inch screens required remounting. Practically every pair of screens in the  $14 \times 17$ -inch cassettes was remounted at least twice because of bulging of the bakelite face. In some instances the screens were remounted three or four times during the year. In spite of these efforts, screen contact remained poor in about one-half of the  $14 \times 17$ -inch cassettes, and several had to be discarded.

The effect of the monsoon upon the cassettes would have been much worse had not some attempt been made to protect them. Due to the lack of dehydrating substances, the cassettes were stored in an electrically heated wooden box (Fig. 3). Two 25-watt bulbs placed in the bottom of this well ventilated box served the purpose to some degree of satisfaction.

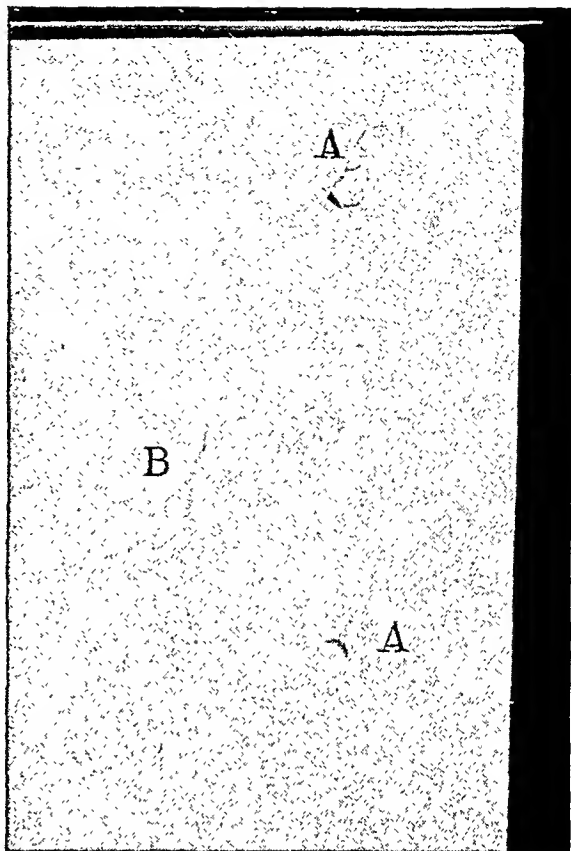


Fig. 4. Intensifying screen in cassette, showing blisters in screen emulsion which had broken open (A) and an intact bleb with its surface unbroken (B).

Not infrequently small blisters developed on the surface of the screens. These thin blebs varied considerably in size, the largest being several centimeters in diameter and about 2 mm. thick (Fig. 4). Their surface was thin and seemed to blend with the surrounding emulsion. Whether these blisters were due to droplets of sweat or humidity alone was never determined.

#### MOVABLE POTTER-BUCKY DIAPHRAGMS AND WAFER GRIDS

Potter-Bucky diaphragms and wafer grids were of standard construction with bakelite (or composition?) surfaces and strip metal edges. They fared no better than the cassettes in the local heat and humidity. One Potter-Bucky diaphragm swelled so badly that it stuck in its housing and could not be moved. When the bakelite and the metal frame were removed,

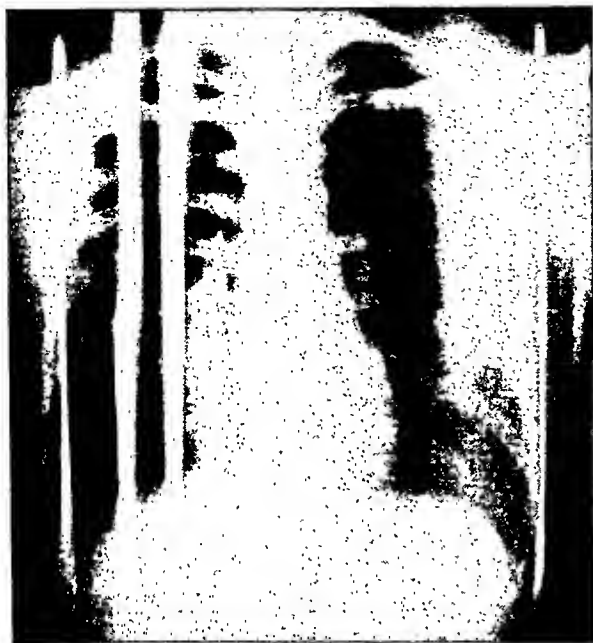


Fig. 5. Test film of wafer grid. Roentgenogram of chest made with wafer grid exposed to monsoon for six months.

1/4- to 1/2-inch ripples immediately appeared in the lead laminated grid. This grid was discarded.

Of the two 14 × 17-inch wafer grids, one was discarded in six months because of distortion. Its lead laminations became twisted and interfered with proper radiography (Fig. 5). Whether the flat sheets of composition material buckled first, allowing the grid itself to warp, or whether the grid was primarily to blame could not be definitely determined. It seemed that, as a result of the heat and humidity, the two flat sheets of composition material buckled first, thereby allowing the grid to change its shape. Indeed, buckling of the flat composition sheets was enough to leave a gap of 1/4 inch between its fitted margins and the metal stripping which held the grid together (Fig. 7). Part of this gap was due to actual bowing of the metal strips themselves, the two strips lying parallel to the lead laminations being the only ones affected. The metal strips lying perpendicular to the lead laminations remained perfectly straight.

We felt that the grid itself also suffered as the result of the climate, in spite of the

shellac, varnish, or other substances with which it was painted by the manufacturer.

#### FLUOROSCOPIC SCREENS

Of three fluoroscopic screens, none tolerated the monsoon. All warped and revealed a wavy appearance with at least five or six crests and troughs across the surface (Fig. 6). The lead glass covering the face of the screen was unaffected. The bakelite back of the screen, however,



Fig. 6. Fluoroscopic screen showing wavy appearance under the lead glass. Patches of color resembling Newton's rings were seen in indirect sunlight at the crest of the waves. The shape of the waves was changed by pressure upon the bakelite back of the screen.

was definitely buckled and had a "give" to it when pressed against the lead glass.

These changes were unquestionably due to moisture. When the lead-glass surface was observed in indirect sunlight, many irregular iridescent patches of color could be seen along the crests of the wavy screen which were in contact with the inner surface of the glass. These looked exactly like Newton's rings. The size, shape, and position of these Newton's ring-like patches were easily affected by pressure against the warped bakelite back of the screen, which brought different surfaces of the emulsion in contact with the lead glass.

Finally, we had the distinct impression that the quality of the fluoroscopic image



seen upon these screens had also been adversely affected. The luminescence of the screen seemed less intense and the images less distinct. Unfortunately we had no means to prove this.

#### SHOCK-PROOF CABLES

Of the eight shock-proof cables used during the past year, four broke down. All the failures developed at the cable terminals, where moisture probably col-

#### DISCUSSION

The importance of protecting x-ray equipment and accessories from heat and humidity cannot be overemphasized. Radiologists in this theater of war were not alone in their difficulties. Similar electrical and structural annoyances were habitual wherever electrical equipment was employed, unless the apparatus had been built especially for a monsoon area.

Corrosion caused no end of trouble and

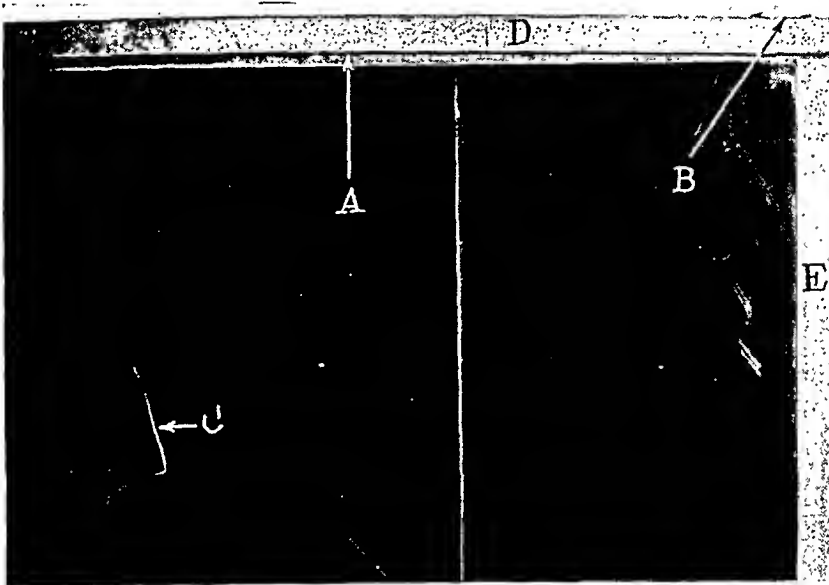


Fig. 7. Corner of wafer grid. Note how the strip metal edge, *D*, bowed and the bakelite sheeting buckled to form the defect at *A*. Metal edge *D* was parallel to the lead laminations in the grid. Metal edge *E*, which was perpendicular to the lead laminations, remained perfectly straight. Two screws in the corner of the grid designated by *B* became loose and had to be replaced by other screws, the caps of which are barely visible. *C* is a film defect.

lected in spite of weekly applications of the prescribed special vaseline. Definite charring was demonstrated in the composition around the ends of the cables and in the tube and transformer housings into which the cable terminals were inserted and had shorted (Fig. 8). Whether this was due to moisture alone or to fluctuations in the primary power supply with high inverses on self-rectified equipment was never determined. Both probably were factors in the cable failures. It was noteworthy that the cables were not punctured near the center; the failures occurred at the cable insertions.

had to be constantly combated by scraping, sandpapering, and repainting, in spite of the fact that thin films of oil were applied to exposed surfaces several times a week. Contactors, switches, rheostats, meters, and viewing boxes all were troublesome at some time or other due to the climate. Of all substances, stainless steel withstood the rigors of the monsoon best. The painted metallic surfaces of the x-ray machines also stood up satisfactorily except at corners from which paint had been chipped or where pieces of metal had been imperfectly welded. Rubber covering for cables of all types retained its texture and



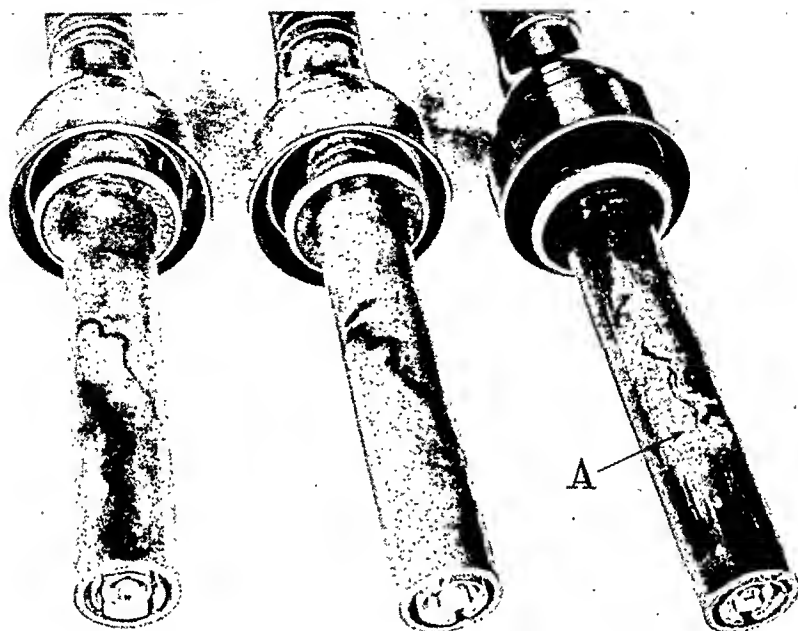


Fig. 8. Shock-proof cables, showing characteristic scarring with charred irregular crevices. At A, the insulating composition was scraped with a knife to reveal the depth of the charred portion in the insulator. (Dirt in the end of the latter terminal was picked up after the cable had failed.)

protective qualities. At the end of one year lead rubber showed no unusual deterioration.

It was our good fortune to have a visitor who had spent over fifteen years installing and repairing x-ray equipment in this part of the world and in other countries where the monsoon is a constant threat. We were grateful to learn that ours was not a unique experience. He had met the same difficulties in other installations even less exposed to heat and moisture than we were.

In some respects radiological departments serving our Armed Forces outside of the continental United States have acted as "proving grounds" for x-ray equipment. Unfortunately we did not possess the technical skill to take full advantage of our opportunity to study thoroughly the behavior of x-ray equipment exposed to heat and humidity. Nevertheless, we learned enough during the

past year to convince us that the efficiency and durability of x-ray equipment used in temperate climates could be enhanced by rectifying the deficiencies observed in our "proving ground" in India.

#### SUMMARY

1. We have reviewed our experiences with x-ray equipment exposed to unusual heat and humidity for approximately one year.
2. We have recorded and illustrated the difficulties encountered in the hope that others working in a similar climate may find them helpful.
3. Most of the disorders seem remediable. Corrective measures may prolong the life and enhance the efficiency of x-ray equipment used in temperate climates.

NOTE: The photographs reproduced in this paper were made by the Museum and Medical Arts Service, Army Medical Museum.

# Depth Dose Measurements at 400 Kilovolts<sup>1</sup>

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IT IS THE PURPOSE of this paper to give the results of depth dose measurements on a 400-kv. machine. Because of the difficulty in making measurements in water, with a removable chamber, the depth doses were measured in a Masonite pressdwood phantom.

Pressdwood is not "standard" and may vary in density and composition. It is therefore advisable to compare the par-

and measuring 30 × 30 cm. The density of the material was about 1.05 gm./c.c. The phantom was always 25 cm. thick.

A group of six boards was drilled so that the ionization chamber fitted snugly into them. These six boards were divided into two sets. In one set the chamber rested; the other set covered the chamber. These two sets will be called the chamber boards. The surface measurements were made with

TABLE I: DEPTH DOSAGE TABLE FOR 400-KV. ROENTGEN RAYS (HVL. 4 MM. CU), FOR FIELDS OF 25, 50, 100 AND 200 SQ. CM.

Depth	60 cm. F.S.D.				70 cm. F.S.D.				80 cm. F.S.D.			
	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.
<i>Per Cent of Surface Dose</i>												
5 cm.	60	64	67	71.5	64.5	68.5	72	75.5	65.5	70	73	76.5
6	51	55.5	59	65	54.5	59	64	68	55.5	59	64.6	70.5
7	44	48.5	52	58.5	46.5	51.2	56.7	61	47.5	50.7	57.5	64.5
8	38	42.5	46	52.5	40	45	50.2	54.5	40.5	44	51	58.8
9	33	36.7	40.5	47.2	34.5	39.3	44.5	48.7	35	39	45.5	53
10	28.5	32	36	42.5	29.8	34.5	39.5	43.5	30.5	34.2	40.3	47.5
15	13.5	15.5	20	24.5	14.5	18.5	21.5	25	15.2	19.3	22.3	27
20	6.5	7.5	10.5	13.5	7.2	10	11.7	14.2	7.7	10.8	12	15
Exit 25	3	4	5	7	3.7	4.5	6	7	4	5.3	6.3	8

ticular sample with water before beginning a series of measurements. A comparison was made between the depth doses in our sample of pressdwood and water, using the same ionization chamber in each, at 100 kv., hvl. 1.86 mm. Al, 200 kv., and 400 kv. The depth doses agreed to within about 5 per cent. Since this obtains, this pressdwood phantom can be used for depth dose measurements instead of water at the above voltages.

## EXPERIMENTAL WORK

Measurements were made with a Victoreen condenser dosimeter, removable type ionization chamber. The phantom was made of Masonite pressdwood, each board having a thickness of 0.373 cm.

the ionization chamber half "submerged" in one set of chamber boards in the same manner as surface measurements are made for water. At other depths, measurements were made with the chamber snugly encased in the chamber boards at definite distances from the surface. Measurements were reproducible. The water phantom used for comparisons had the same dimensions as the pressdwood phantom.

The radiation from the 400-kv. machine had a half-value layer of 4 mm. Cu when a 2 mm. Cu + 1 mm. Al filter was added. The size of the field was obtained by means of an Oddman light box, which gave the outline and center of the field and also indicated the distance. The adjustable diaphragm at the bottom of the box was located at 53 cm. from the target.

The roentgen rays from the 200-kv.

<sup>1</sup> Accepted for publication in May 1944.

DEPTH DOSE CURVES FOR 400 KV  
60 CM. FSD.  
HVL 4 MM CU

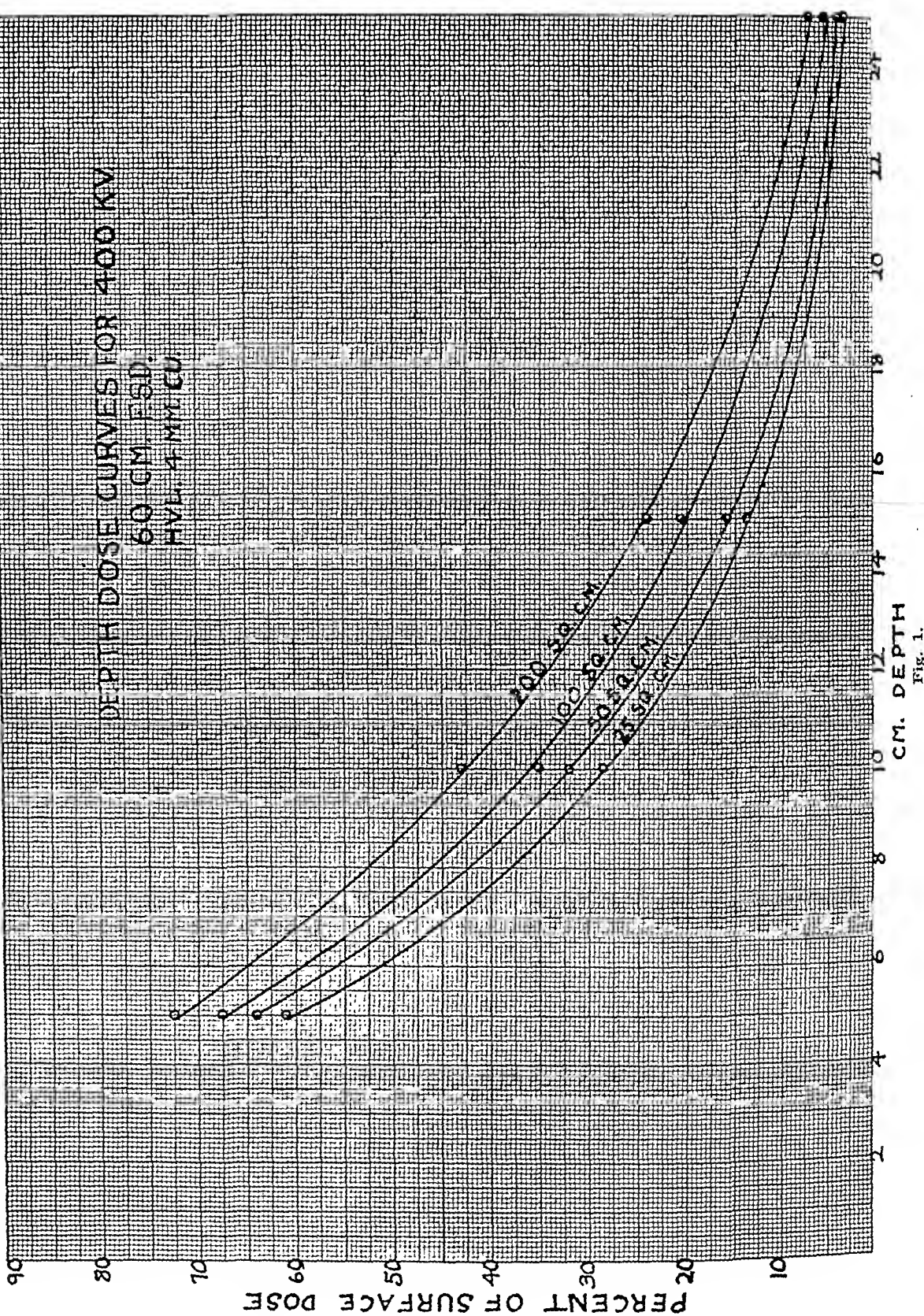


Fig. 1.

TABLE II: COMPARISON OF DEPTH DOSES FOR 400 kv., HVL. 4 mm. Cu WITH 200 kv., HVL. 2 mm. Cu, AT 80 cm. F.S.D.

Depth	4 cm. × 5 cm.	5 cm. × 5 cm.	10 cm. × 10 cm.	
	200 kv.	400 kv.	200 kv.	400 kv.
5 cm.	57	65.5	70	73
7	39	47.5	54.5	57.5
10	23	30.5	37	40
15	10	15.2	18.8	22.3

machine had a half-value layer of 2.2 mm. Cu. The fields were outlined by means of the cones coming down to the surface of the phantom. The limiting diaphragm was 26 cm. from the target on top of the cone.

Table II. The gain in depth dose for the smaller field is apparent.

*Comparison of Depth Doses Obtained by Different Investigators:* The depth doses for 400 kv., for half-value layers ranging from 3.5 mm. Cu to 6 mm. Cu, as given directly or extrapolated for the specified distance, are tabulated in Table III. Where there are no numerical superscripts, the figures were obtained directly from curves or tables published by the indicated investigator. In the other cases the figures were obtained by using the inverse-square law to change from a F.S.D.

TABLE III: COMPARISON OF DEPTH DOSES FOR DIFFERENT INVESTIGATORS AT 70 cm. AND 80 cm. F.S.D. AND DIFFERENT FIELD SIZES

	hvl. in mm. Cu	70 cm. F.S.D.						80 cm. F.S.D.					
		25 sq. cm.		100 sq. cm.		200 sq. cm.		25 sq. cm.		100 sq. cm.		200 sq. cm.	
		5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth
		cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
Jacobson	4	64.5	29.8	72	39.5	75.5	43.5	65.5	30.5	73	40	76.5	47.5
Reinhard and Goltz	(0.06 A°)	60	30	72	41	71	42 <sup>4</sup>	...	...	...	...	...	...
Meredith and Stephenson	6.32	58	31.6 <sup>1</sup>	69	42.5 <sup>3</sup>	71	46	...	...	...	...	...	...
Mayneord and Lamerton	4	57.5	30.3 <sup>2</sup>	71	42.5	75	49.1	57.4	30.2 <sup>5</sup>	70.6	42	75	48.6
Glasser	3.6-5.2	...	...	...	...	...	...	...	...	...	43	...	47
Corrigan	.....	...	...	...	...	80.5	52 <sup>5</sup>	...	...	...	...	...	...

<sup>1</sup> Extrapolated by inverse square law from 50 cm. F.S.D. This depth dose is for a 20 sq. cm. field.

<sup>2</sup> 20 sq. cm. field extrapolated from 60 cm. F.S.D.

<sup>3</sup> Extrapolated from 50 cm. F.S.D.

<sup>4</sup> These values are for a 400 sq. cm. field, not reduced to 200 sq. cm. for lack of a conversion factor.

<sup>5</sup> These values are for a 400 sq. cm. field. Extrapolated from 60 cm. F.S.D.

<sup>6</sup> These values are for a 20 sq. cm. field.

#### RESULTS FOR PRESSDWOOD

The depth doses obtained by using the Masonite pressdwood phantom, density 1.05 gm./c.c., are plotted for 400 kv. and 60, 70, and 80 cm. F.S.D. for fields of different sizes in Figures 1, 2, and 3. Since it is sometimes more convenient to use tables, Table I has been compiled on the basis of the curves.

*Comparison of 400-kv. and 200-kv. X-Rays in Pressdwood:* The depth doses for 200 kv. were measured for fields 4 × 5 cm. and 10 × 10 cm., at 80 cm. F.S.D. These curves are plotted in Figure 3, which shows, also the doses with 400 kv. for the same distance. The results are tabulated in

of 60 cm. to 70 cm. No correction was made when a field of 400 sq. cm. was compared with a 200 sq. cm. field, for lack of an adequate conversion factor.

The density of the pressdwood phantoms used by other investigators was not always given. Meredith and Stephenson used pressdwood of a density of 1.08 gm./c.c. Glasser used purple heart wood, the density of which closely approximates that of water. The values given by Mayneord and Lamerton are averages of depth dose data of a number of investigators.

Considering the possible differences in phantoms, density of material, diaphragming, and set-ups, it is encouraging to find



DEPTH DOSE CURVES FOR 400 KV.  
70 CM. FSD.  
HVL 4MM.Cu.

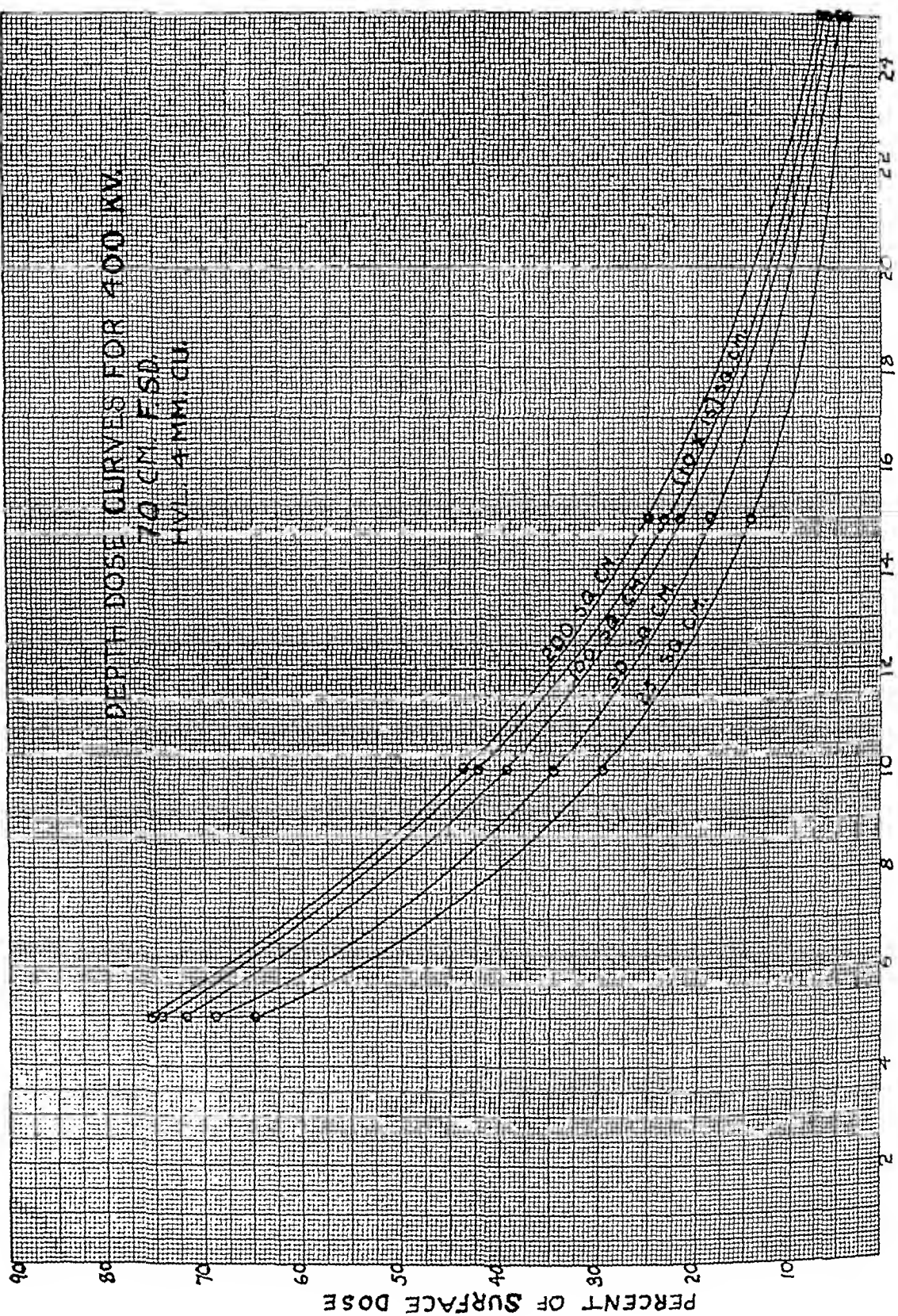


Fig. 2.

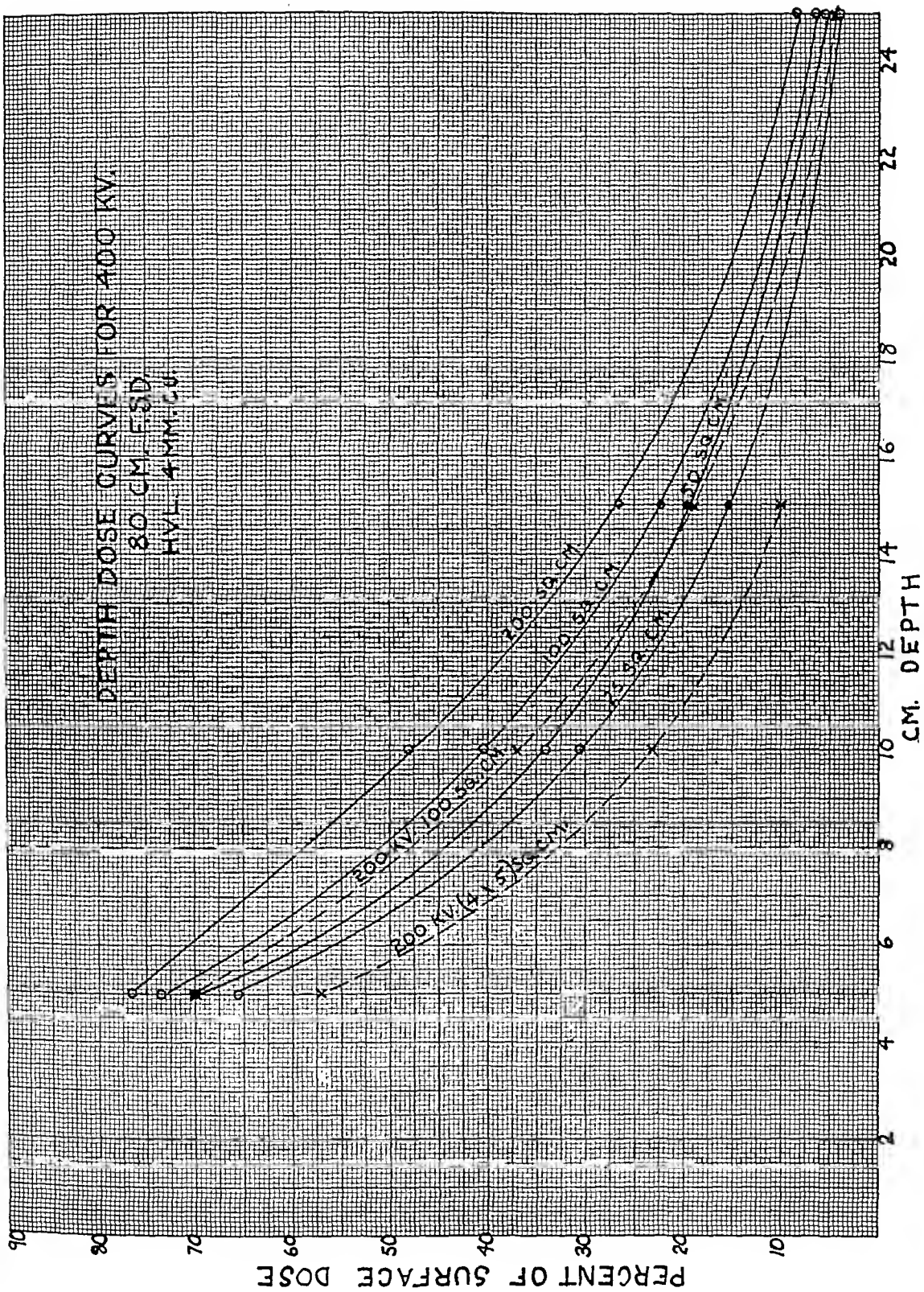


Fig. 3.

that the agreement at a depth of 10 cm. is good.

The 5-cm. depth doses do not agree so well, but this is to be expected. Different sizes of ionization chambers and slight differences in the depth distance at 5 cm. may account for most of the discrepancies.

### DISCUSSION

The values for depth doses given in this paper are about the average of those of the other investigators. The question arises as to how well the measurements in pressdwood at 400 kv. duplicate body measurements. If the depth doses for the sample of pressdwood employed are approximately the same as for water, it is permissible to assume that they correspond to tissue measurements.

Spiers (23) believes that, despite the difficulties of measuring in water, it is the most satisfactory medium. He finds that some pressdwoods agree with water reasonably well for wave lengths shorter than  $0.2 \text{ A.}^\circ$ , which obtains, of course, at 400 kv. The ideal material, other than water, which will parallel tissue absorption for different voltages and be standard, reproducible, and convenient has yet to be found. Perhaps some of the plastics or a "standard" pressed material may be so used.

### SUMMARY

1. Curves and tables showing depth doses for 400 kv., hvl. 4 mm. Cu, in a pressdwood phantom of 1.05 gm./c.c. density, are given for different fields.

2. Curves showing depth doses obtained in the same manner for 200 kv. are plotted on the same graph for comparison with 400 kv.

3. A table showing the data obtained by different investigators for depth doses at 400 kv. is given.

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# A New Principle in Roentgenography of the Lateral Lumbar Spine<sup>1</sup>

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THE X-RAY examination of the lumbar spine has always been attended by considerable difficulty. Anatomically, the spine consists of twenty-four vertebral bodies separated by cartilaginous pads to permit flexibility. Roentgenographically, the demonstration of each vertebra and

made for the curvature, but one important factor is neglected. That factor is the nature of the beam of radiation.

X-rays leave the anode of the tube in a divergent beam, only the central portion

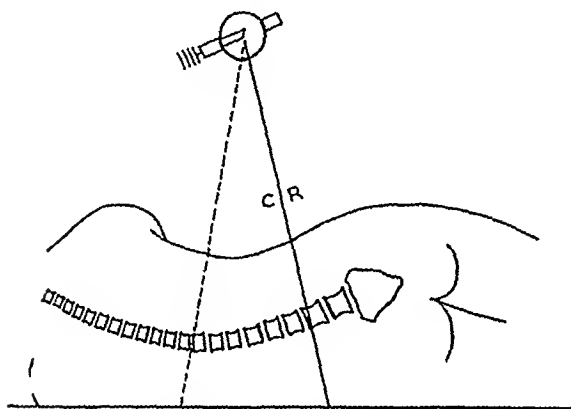


Fig. 1. Tube tilted to compensate for lumbar curve. Result: The intervertebral spaces in the lower thoracic and upper lumbar areas are obscured.

each intervertebral joint space is desired. This should be accomplished without distorting the shadow of the vertebral body over the joint space. As the patient lies on the side in position for a lateral roentgenogram, there is a curve in the spine due to the difference in width at the shoulder and hip areas, as compared to the waist. This is especially marked in women.

There are two methods generally advocated for correction of the curve of the spine when the patient is positioned for a lateral roentgenogram of the lumbar spine. One calls for tilting the tube until the central beam of radiation is at right angles to the plane of the region involved. In the other the spine is bolstered at the waist to eliminate the curve. Compensation is thus

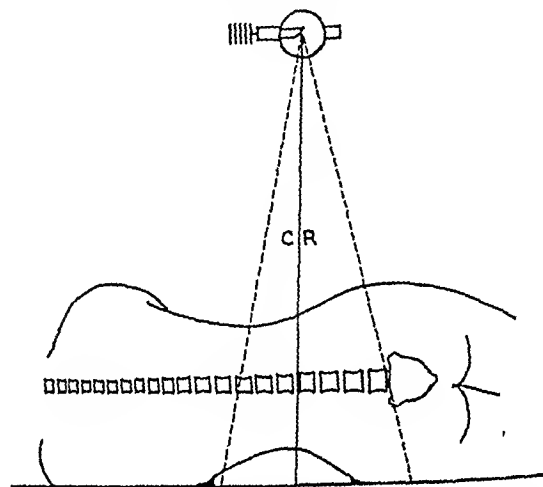


Fig. 2. Lumbar curve straightened by a non-opaque pad at the waist. Result: The intervertebral spaces at both ends of the roentgenogram are obscured.

of which is perpendicular to the table top or the cassette. When the tube is tilted, as in the first method (Fig. 1), the central ray is directed through the level of the third lumbar vertebra. The intervertebral spaces in this region are demonstrated, but above this they are not well shown, being obscure in the upper lumbar and lower thoracic area. This is due to the upward curve of the spine in this region and the divergence of the x-ray beam.

In the second method (Fig. 2) the spine is bolstered up to a more horizontal plane with non-opaque pads. This method completely disregards the divergent nature of the radiation. As a result, the intervertebral spaces at either end are obscured, only those in the central portion of the roentgenogram being properly demonstrated.

<sup>1</sup>From the Department of Radiology, Columbia Hospital, Milwaukee, Wis., Dr. S. A. Morton, Director. Read before the Wisconsin Society of X-ray Technicians, Milwaukee, Sept. 25, 1943. Accepted for publication in June 1944.

Each method serves a purpose, but neither is satisfactory for the delineation of the entire lumbar spine on a single film.

The procedure to be described will consistently give accurate results and will show more vertebral bodies and interspaces without distortion than either of the methods mentioned above. The divergent beam of radiation is utilized to definite advantage instead of being regarded as something to be avoided. The distance factor is variable, being based on the radius of the curve

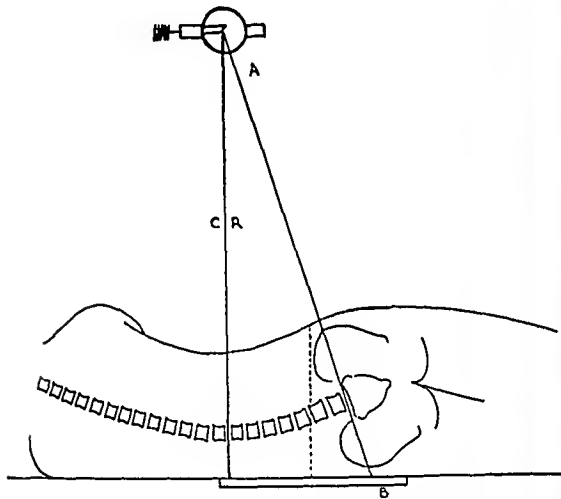


Fig. 3. Author's technic, in which the tube film distance is not fixed but is used as a variable factor. The procedure is as follows:

1. Determine the curve of the lumbar spine
2. Center the tube over the low point of the curve, usually at D11 or 12
3. Center the cassette at the iliac crest
4. Raise or lower tube to the point where line A-B intersects CR.
5. Correct exposure factors to compensate for increase or decrease of distance

*Result:* All intervertebral spaces are clear, even in patients with marked scoliosis.

of the spine, instead of being fixed at some convenient level.

The patient is placed in the usual position for lateral roentgenography of the lumbar spine. Because of its flexibility, and the fact that the shoulder and hip areas are wider than that of the waist, the spine lies in a long sweeping curve from the shoulders to the lumbosacral joint (Fig. 3). The tube is centered over the low point of this curve and directed perpendicularly to the table top. This point usually is at the level



Fig. 4. Lateral view of lumbar spine made with author's technic.

of the eleventh and twelfth thoracic vertebrae. The cassette is centered at the level of the iliac crest, and the tube is centered not to it but to the low point of the curve.

The tube distance, as pointed out above, is a variable factor based upon the radius of the curve of the spine. If the curve is pronounced, the distance is shortened; when it is less marked, a greater distance is used. The divergent roentgen beam represents the radii of the curve, converging at a center point; this center point is the position of the tube. In practice this center is found by determining the low point of the curve. Then with a pointer or by inspection a line is projected through the lumbosacral joint (Line A-B, Fig. 3) and the tube is raised or lowered to the point where

it intersects the projected line. Before making the exposure, the proper adjustment for increased or decreased distance is calculated.

This technic provides a clear, unobscured image of all vertebral bodies and intervertebral spaces (Fig. 4). It can be employed with most of the equipment in use today. If, however, the equipment does not permit a distance greater than 36 inches, it may be difficult in many cases to obtain satisfactory results, since the average distance for optimum results is 38 to 40 inches.

#### SUMMARY

A method is described whereby satisfactory roentgenograms demonstrating clearly each intervertebral space can be obtained. The divergence of the roentgen beam is utilized and distance is varied.

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NOTE: Subsequent to the initial presentation of this paper, an article by Cesare Gianturco appeared in the *American Journal of Roentgenology* (50: 695, November 1943), suggesting utilization of the divergent nature of the roentgen beam. This did not, however, stress the importance of variable distance and cassette center.



# Further Studies on the Relation between Radiation Effects, Cell Viability, and Induced Resistance to Malignant Growth<sup>1</sup>

## II. Effects of Roentgen Rays on Bagg-Jackson Mouse Carcinoma 755 Irradiated *in Vitro* and *in Situ*

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IN A PREVIOUS study (1) attempts were made to correlate the effects of irradiation on living processes observed in experiments carried out *in vitro* with radiation effects *in vivo*. Mouse sarcoma 180 was used as an experimental subject in both procedures. While a dose of about 60,000 r in air was required to prevent the growth of tumor particles in a culture medium, a dose of 4,000 to 5,000 r in air applied to similar tumor particles prior to implantation was sufficient to prevent their proliferation in the animal organism. The implanted tumor fragments previously irradiated with dosages in the neighborhood of 5,000 r in air rendered the animals resistant to subsequent viable (non-irradiated) implants of the same type of tumor. In these animals no detectable tumor developed; that is, they became immune to tumor growth. On the other hand, animals implanted with fragments previously irradiated with dosages of about 60,000 r in air failed to show any such resistance. The massive dose (60,000 r in air), therefore, which prevented proliferation *in vitro*, was destructive not only for the proliferative power of sarcoma 180, but also for its immunizing factor. It was thus demonstrated that, in order to induce "immunity" to subsequent viable implants, the tumor fragments had to be attenuated, but not destroyed, by a relatively critical dosage of radiation. For sarcoma 180 this dosage was about 5,000 r in air.

It was deemed of interest to apply this method of investigation to other types of tumors, particularly to those of known genetic constitution grown in an inbred

strain of animals. Such studies may have a twofold significance: (1) as furnishing a more precise measurement for the effectiveness of given dosages of radiation, the indicator being the ability of the irradiated implant to produce either a tumor or resistance to subsequent viable tumor implants; (2) as permitting generalizations on the possibility of inducing resistance to malignant growth by means of properly irradiated tumor implants. The present paper represents such an attempt, being one of a series of proposed studies.

### METHOD AND MATERIAL

The tumor used in this experiment was the Bagg-Jackson mouse carcinoma 755, grown in an inbred strain of mice, C57 "Y" black (2). This tumor originally arose in C57 black mice which had been subjected to forced breeding. The "Y" designates a substrain which exhibited a high mammary tumor incidence. The tumor is an alveolar mammary adenocarcinoma, consisting of small acini and, to a lesser extent, of sheets and strands of cells. It is firm in consistency, encapsulated, relatively slow growing, rarely becomes hemorrhagic, and never regresses spontaneously.

Since the radiosensitivity of this type of tumor has not been sufficiently studied, the first task was to determine the dose of radiation applied *in vitro* which would prevent an implant from producing a tumor in the animal organism and the dose required to make an actively growing tumor regress *in situ*, for it was observed, in some instances, that animals in which tu-

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TABLE I: TUMORS PRODUCED BY IRRADIATED IMPLANTS  
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, H.V.L. 0.9 mm. Cu)

Experiment Number	Dose (r in air)	Latent Period (days)	"Takes" (per cent)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)
1	1,200	11-13	100.	5 × 5 × 4	58	35 × 28 × 19
2	1,500	14-16	100.	7 × 6 × 4	61	38 × 28 × 17
3	1,800	14-19	100.	4 × 4 × 3	59	27 × 19 × 12
4	2,000	16	100.	6 × 5 × 4	60	19 × 16 × 12
5	2,500	16-23	100.	5 × 4 × 3	58	16 × 16 × 10
6	3,000	18	85.5	6 × 4 × 4	58	16 × 12 × 9
7	3,500	18-20	58.6	4 × 3 × 3	60	12 × 9 × 6
8	4,000	20-24	25.0	4 × 3 × 2	57	9 × 8 × 4
9	4,300	26	6.6	3 × 2 × 2	62	8 × 5 × 4
10	4,500	0	0	0	0	0

Remarks: Each experiment included 5 or 6 mice. Therefore, the sizes recorded represent averages of 5 or 6 tumors. The tumors were measured in three dimensions.

Some of the experiments were repeated, and the results recorded are averages of single and repeated experiments.

In experiment 9, only one of 15 mice in 3 repeated experiments showed a tumor twenty-six days after implantation.

Three sets of experiments with doses of 4,500 r gave negative results, *i.e.*, no "takes" were observed.

mors regress either spontaneously or as a result of radiation treatment became resistant, also, to subsequent tumor implantation.

The same technic was used here as in previous experiments (1). The surface portion of a ten-to-twelve-day-old tumor was cut with sharp scissors into tiny fragments, varying from 1.2 to 2.0 mm. in diameter and weighing from 0.8 to 1.5 mg. Some of these fragments were used for implantation into control mice. Others were spread on a No. 1 round cover slip which had been attached to a mica sheet, covered with a Maximow slide, sealed with paraffin, and irradiated. In order to avoid evaporation of the tissue water, a strip of moist filter paper was placed in the concavity of the Maximow slide before sealing with paraffin. The radiation was applied by a pulsating potential oil-cooled Coolidge tube. The radiation factors were: 200 kv., 20 ma., 0.5 mm. Cu plus 1.0 mm. Al filtration, and 0.9 mm. Cu H.V.L. The tumor fragments were irradiated at 12.5 cm. distance from the target, and the average intensity was 577 r in air per minute. In figuring the dose received by the tumor fragments, the absorption of the radiation by the covering glass and mica sheet, which was about 10 per cent, was taken into consideration. The dose of radiation in each case was applied during a single exposure. Within fifteen to twenty min-

utes after irradiation, the tumor fragments were implanted into animals midway between the groin and the axilla by means of a trocar. Non-irradiated control tumor fragments were similarly implanted.

The majority of mice used in these experiments were males from five to six weeks old, weighing from 18 to 25 gm. They were kept in wooden boxes and fed with Purina dog chow and water *ad libitum*. Lettuce was added to the regular food once or twice weekly. As criteria of the radiation effects, the latent period, the number of "takes," and the size of the tumors produced by the irradiated implants were taken into consideration. The same indices were applied to tumors produced by non-irradiated implants.

For the study of the effects of x-rays on the tumor *in situ* a certain number (3 or 4) of tumor-bearing control mice were used from each series. During exposure these mice were fastened with adhesive tape to a sheet of lead 4 mm. thick, in which holes 2.5 cm. in diameter were made. The lead sheet was placed on a wooden stand. The mice were tightly fastened on the sheet in such a position that only the tumor was exposed through the hole. The radiation factors were the same as those used in the irradiation of the tumor fragments, except that the target-skin distance was 50 cm. The average intensity amounted to 43 r in air per minute. The tumors were ir-

TABLE II: TUMORS PRODUCED BY NON-IRRADIATED CONTROL IMPLANTS

Experiment Number	Latent Period (days)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)	Remarks
1	9	4 × 3 × 2	58	38 × 27 × 16	Each experiment included 5 or 6 mice. Therefore, the sizes recorded in this table represent averages of 5 or 6 tumors. The tumors were measured in three dimensions.
2	10	5 × 5 × 3	61	41 × 30 × 24	
3	10	5 × 5 × 3	59	35 × 28 × 18	
4	10	4 × 3 × 3	60	37 × 25 × 19	
5	7	3 × 2 × 2	58	36 × 31 × 26	
6	10	6 × 5 × 4	58	37 × 28 × 16	
7	9	5 × 4 × 3	60	39 × 28 × 21	
8	10	4 × 3 × 2	57	37 × 29 × 16	
9	10	5 × 4 × 4	62	42 × 38 × 20	
10	8	3 × 3 × 2	61	39 × 25 × 15	

radiated three times weekly, receiving one dose of 500 r in air at each exposure. Preliminary experiments with smaller doses of x-rays showed a continuous increase in the size of the initial tumor for a period of two weeks. The choice of 500 r in air was made because the mice seemed to endure repeated applications of this dose. Arrest of the tumor growth was obtained after several treatments. In some instances, where the mice did not appear in good health during the course of treatment, the irradiation was interrupted for a few days. (It should be pointed out that in this experiment attention was focused on producing regression of tumors for testing their capacity of inducing resistance in the host and not on the particular method of treatment.) The tumors, both irradiated and control, were measured in three dimensions twice weekly by means of calipers.

#### OBSERVATIONS ON IRRADIATED IMPLANTS OF CARCINOMA 755

In Table I are recorded typical results obtained after implantation of irradiated tumor fragments in mice. Each experiment comprised an average of five or six animals. Where tumors consisted of two separate lobes, the average size of both lobes was taken into consideration. Up to a dose of 1,200 r in air no marked difference in the rate of growth could be detected between the irradiated and control implants.

The effectiveness of irradiation on the tumor implants was primarily manifested in the latent period, *i.e.*, the lapse of time between the implantation of the tumor fragments and the occurrence of tumors of

a measurable size. Among the animals which were implanted with non-irradiated tumor fragments, a latent period varying from seven to ten days occurred, while among the animals inoculated with irradiated tumor fragments the latent period extended from eleven to twenty-six days, varying with the dose. Some sets of experiments showed variation in the latent period for implants exposed to the same dose of x-rays. An analysis of the data for all experiments reveals that between 1,200 and 4,000 r in air the latent period varied from 11 to 20 days in some experiments and in others from 13 to 24 days. The prolonged latent period was not consistent, for in experiments 4 and 6 only one latent period occurred. Furthermore, in experiment 9, only one of 15 mice developed a tiny tumor twenty-six days after implantation, though the experiment was twice repeated. Consequently only one prolonged latent period was observed in this series of three experiments.

To explain the prolonged latent period there are two alternatives: first, that not all cells are equally affected by a given dose of radiation, which may be due to a difference in susceptibility of the cells during different stages of mitosis; second, that partially injured tumor cells may recover and produce a tumor after a comparatively longer period.

The size of the tumors produced by irradiated implants may be utilized as further evidence of effects produced by given doses of x-rays. Two-month-old tumors have been arbitrarily chosen for comparison. This relatively long period appeared

TABLE III: EFFECTS OF FILTERED X-RAYS ON THE GROWTH IN SITU OF CARCINOMA 755  
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, H.V.L. 0.9 mm. Cu)

Experi- ment Number	Size of Tumor Before Irradia- tion (mm.)	Total Dose (r in air)	Size of Tumor After Irradia- tion (mm.)	Remarks
1	22 × 13 × 11	4,500	8 × 8 × 5	The mouse died 22 days after the last treatment; the tumor was firm and fibrotic, not movable.
2	18 × 16 × 8	4,500	6 × 4 × 3	The mouse died 15 days after the last treatment.
3	17 × 12 × 8	4,500	9 × 6 × 4	The mouse died 12 days after treatment.
4	15 × 12 × 9	5,500	0	Tumor disappeared 7 weeks after treatment; gray hair appeared on the epilated sites.
5	17 × 13 × 11	5,500	6 × 4 × 3	The mouse died 6 weeks after treatment.
6	18 × 15 × 13	5,500	0	This mouse lived 6 weeks after the disappearance of the tumor. Gray hair appeared in the epilated sites.
7	18 × 8 × 6	5,500	7 × 6 × 4 }	Both mice died during the course of tumor regres- sion.
8	17 × 10 × 6	5,500	3 × 2 × 2 }	
9	16 × 9 × 6	5,500	0	
10	11 × 10 × 9	5,500	0	The mouse survived 5 weeks after the disappear- ance of the tumor. Gray hair appeared on the epilated sites during this period.
				The mouse died 3 weeks after the disappearance of the tumor.

necessary for evaluation of the irradiation effects on implants, because of the moderate rate of growth of this tumor. As can be seen from Tables I and II, the tumors produced by irradiated implants within a period of about two months are smaller than the tumors produced by unirradiated implants. This difference is more striking in the experiments with larger doses of radiation. Thus, in experiments, 1, 2, and 3 (Table I) the difference in average size between the tumors produced by an irradiated implant and those in the controls, is not so great as in the later experiments. A drastic decrease in the average tumor size occurred in experiments 7, 8, and 9, *i.e.*, within the threshold doses of 3,500 and 4,300 r in air. These observations parallel those of the prolonged latent period.

In summarizing the results recorded in Table I, it may be concluded that the lethal dose for implants of carcinoma 755, under the experimental conditions here applied, lies between 4,300 and 4,500 r in air. Furthermore, the tumors produced by the implants irradiated with 2,000 to 4,300 r grew more slowly and were smaller than those produced by non-irradiated implants in the same length of time.

OBSERVATIONS ON TUMORS (CARCINOMA 755)  
IRRADIATED IN SITU

Of 39 tumor-bearing animals treated with x-rays, only 10, recorded in Table III,

will be discussed here. As previously mentioned, the response of Bagg-Jackson adenocarcinoma 755 to x-rays has not hitherto been investigated to any great extent.<sup>2</sup> Some details obtained from this study seem, therefore, of special interest.

While in our previous experiments (1) mouse sarcoma 180 regressed rapidly after a dose of 2,000 to 3,000 r in air, the mammary adenocarcinoma (carcinoma 755) used in the present experiment increased in size after a similar dose. Moreover, a characteristic of carcinoma 755 is its slow regression after the course of treatments. It was weeks or months before the tumor decreased to one third of its original size or before it disappeared completely after a total dose of 5,500 r in air. It became firm and attached to the skin during the course of regression, thus indicating that fibrosis occurred within the mass and its surrounding area. In some instances the fibrotic tumor remained stationary for some time, *i.e.*, no change in size could be detected by measurement with calipers. After such a

<sup>2</sup> The only reference available is a publication by Plaut et al. (3), who studied the influence of diet and foster nursing on the response of the Bagg-Jackson tumor to x-rays. The authors applied a single dose of 2,500 r in air to the tumor, which was on the lateral aspect of the right thigh. They admit, however, that the experiment was complicated by the implantation of another type of tumor (Yale carcinoma) into the same animal and also by the variations in the diet. Consequently they did not draw any definite conclusions from their study.



period, the tumor either renewed its growth or was gradually absorbed. Seldom did ulceration occur in actively growing tumors or in tumors which regressed.

The six mice recorded in Table III, experiments 1, 2, 3, 5, 7, and 8, exemplify the slow regression of the tumors and the death of animals when the tumor had decreased to about one third of the original size. No metastases were discovered at autopsies of animals in which tumors regressed either partially or completely.

Of the four mice successfully treated (experiments 4, 6, 9, and 10), No. 4 may serve as a typical case. This animal received a total dose of 5,500 r in air. Epilation of the left and right sides of the lateral thoracic regions occurred during and after the radiation treatments. The tumor decreased in size after receiving about 4,000 r in air. It regressed slowly following the total dose of 5,500 r and disappeared seven weeks after the last treatment. This mouse survived three months after the disappearance of the tumor. During this period gray hairs instead of the natural black ones appeared on the epilated lateral thoracic regions (left and right sides). Though irradiation was confined to an area only 2.5 cm. in diameter on the left side, where the tumor was located, the entire right side of the mouse, including the leg, was covered with gray hair (Fig. 1). The occurrence of gray hair on the right side of the mouse may indicate an exit effect of the rays. Similar observations were made on mice 6, 9, and 10, which also survived several weeks after disappearance of the tumor. The restoration of growth of hair on the epilated areas demonstrates the partial recovery of hair follicles after doses as high as 5,000 to 5,500 r in air. These doses, on the other hand, were destructive to the pigment, since the new growth of hair was gray instead of the original black. These observations substantiate those of Hance and Murphy (4), who described the growth of white hair on colored mice in areas temporarily epilated after irradiation. No ulceration of the skin of the irradiated areas was noticed, an observa-



Fig. 1. Growth of gray hair on epilated areas following irradiation.

tion indicative of the high resistance of mouse skin to roentgen radiation.

Twenty-nine of the 39 tumor-bearing mice treated with x-rays died during or shortly after the course of treatment. The high mortality among the mice treated with x-rays in comparison to the control tumor-bearing mice, which survived six to eight weeks longer, may have been due to the effects of the x-rays on the internal organs. The importance of a better method of treatment to secure more protection of the animal organism is evident. It is obvious that the usual high mortality following direct irradiation of the tumors *in situ* precludes this procedure as a practical method of inducing "immunity." The next logical step is to experiment along the lines which have been followed with sarcoma 180, using properly attenuated implants irradiated *in vitro*, thus sparing the host the harmful effects of x-rays on the internal organs and increasing his chance of survival. This holds true particularly in experiments on small animals. The use of larger animals for this type of experiments may, however, be more satisfactory.

The small number of cured animals in the present study limited experiments to determine their response to further viable tumor implants. One attempt was made. Mouse 4, which survived for the longest period, was reinjected with a fresh viable implant of carcinoma 755 two months after regression of the first tumor. The implant produced a tumor  $3 \times 3 \times 2$

mm. sixteen days following implantation. This tumor slowly increased in size and measured  $8 \times 5 \times 4$  mm. at the death of the mouse, eighteen days later. Sections of the tumor, which was removed shortly after the death of the animal, contained viable tumor cells.<sup>3</sup> The question, whether or not this tumor would have continued to grow or would eventually have regressed

SUMMARY AND DISCUSSION

The purpose of this study was twofold: first, to determine what dose of x-radiation applied to tumor fragments *in vitro* would inhibit their growth upon transplantation into mice, and second, to determine the dose of radiation which would make an actively growing tumor regress *in situ*.

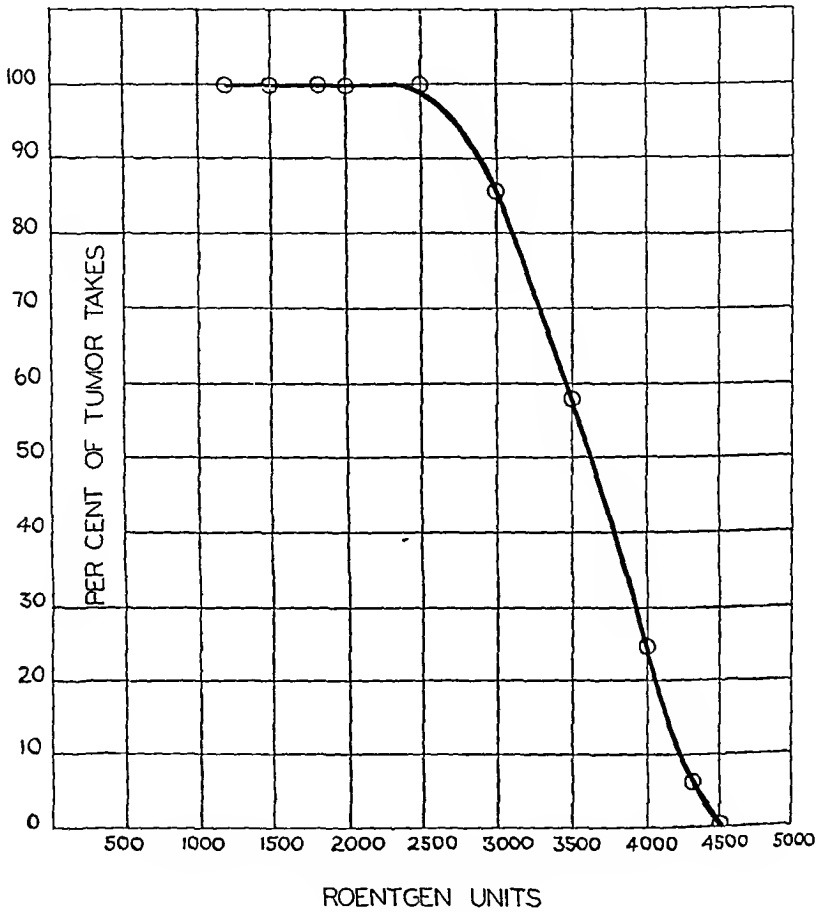


Fig. 2. Survival curve for mammary adenocarcinoma 755 exposed to roentgen rays.

cannot be answered. The latent period of sixteen days and the relatively slow rate of growth suggest some resistance on the part of the host. It may also be assumed that this resistance would have been greater, had the lapse of time between the regression of the first tumor and reimplantation been shorter. No definite conclusion can be drawn, however, from a single case.

<sup>3</sup> I am indebted to Dr. F. E. Stewart of Memorial Hospital, New York, for the interpretation of the histologic slide.

It was found, that a dose of 3,500 r in air (H.V.L. 0.9 mm. Cu) applied to tumor particles of the Bagg-Jackson mammary mouse carcinoma 755, *in vitro*, permitted 58.6 per cent "takes," while a dose of 4,500 r in air entirely prevented the growth of the irradiated implants. A comparison of the results obtained in this study with those obtained by other investigators seeking to determine lethal doses for various tumors irradiated either prior to implantation or *in situ*, is presented in Tables IV

TABLE IV: DOSE OF ROENTGEN RAYS INHIBITING GROWTH OF TUMOR FRAGMENTS IN SITU, AS DETERMINED BY DIFFERENT INVESTIGATORS

Investigator	Type of Tumor	Physical Factors	Dose of Radiation	Remarks
Westergaard (5)	Jensen mouse carcinoma	Bauer tube 0.5 ma. 14 cm. distance No filter	1 $\frac{1}{4}$ S.E.D.	
Contamin (6)	Mouse adenocarcinoma B	0.8 ma. 12 cm. distance 0.2 mm. Al	About 3 hr.	No physical factors given
Wedd and Russ (7)	Mouse carcinoma 63	Sparkgap 6-10 cm. 4 amp.	About 5 S.E.D.	No exact physical factors given
Wood and Prime (8)	Sarcoma 180	25 kv.; 5 ma.	About 5 S.E.D.	
	Sarcoma 10	23 cm. f.d.	About 4 S.E.D.	
	Flexner-Jobling rat carcinoma and mouse carcinoma 11	3 mm. Al		
Kok and Vorlaender (9)	Ehrlich mouse carcinoma	80 kv.; 8 ma. 20 cm. f.d. 0.5 mm. Cu	1,500 e About 9 S.E.D.	
Krebs (10)	Mouse carcinoma Mouse sarcoma	142 kv.; 2.8 ma. 23 cm. f.d. 5 mm. Al	About 6 S.E.D.	The sarcoma was produced by tar. The carcinoma arose among the mice used by the author
Packard (11)	Sarcoma 180	550 kv.; 3.2 ma. 50 cm. distance 1 mm. steel filter	2,700 r in air	
Sugiura (12)	Sarcoma 180	200 kv.; 15 ma. 50 cm. distance 0.2 mm. Sn, 0.25 mm. Cu, 2.0 mm. Al	2,800-3,000 r in air	
Lawrence et al. (13)	Mouse carcinoma	200 kv. 36 cm. f.d. 0.45 mm. Cu and 1 mm. Al	4,400 r in air	The tumor particles weighed about 8 mg.
Lawrence et al. (14)	Mouse sarcoma 180	200 kv. 36 cm. f.d. 0.45 mm. Cu and 1 mm. Al	2,800-3,000 r in air	
Toniolo (15)	Galliera sarcoma	165 kv.; 3 ma. 25 cm. distance 3 mm. Al and 0.5 mm. Cu	3,500 r in air	The same dose destroyed the tumor <i>in situ</i>
Sahler and Warren (16)	Brown-Pearce rabbit carcinoma	200 kv.; 25 ma. 0.5 mm. Cu and 1 mm. Al	6,000 r in air	
Eisen (17)	Transplants of a spontaneous mammary adenocarcinoma (R2426)	200 kv. 37 cm. f.d. 0.5 mm. Cu	5,000 r in air	
Henshaw (18)	Mouse sarcoma 37	200 kv.; 20 ma. 25 cm. f.d. 0.25 mm. Cu and 0.55 mm. Al	5,000 r in air	
Goldfeder	Mouse adenocarcinoma 755	200 kv.; 20 ma. 0.5 mm. Cu and 1 mm. Al	4,300-4,500 r in air	

TABLE V: DOSE OF ROENTGEN RAYS CAUSING REGRESSION OF TUMORS IN SITU, AS DETERMINED BY DIFFERENT INVESTIGATORS

Investigator	Type of Tumor	Physical Factors	Dose of Radiation	Remarks
Contamin (6)	Mouse adenocarcinoma B	0.8 ma. 12 cm. distance 0.2 mm. Al	About 3 hr.	No physical factors given. Single exposure
Wedd and Russ (7)	Jensen rat sarcoma	Sparkgap 6-10 cm. 4 amp.	About 4 S.E.D.	Single exposure
Wood and Prime (8)	Sarcoma 180 Sarcoma 10	25 kv.; 5 ma. 23 cm. f.d. 3 mm. Al	About 5 S.E.D.	Single exposure
Kok and Vorlaender (9)	Ehrlich mouse carcinoma	80 kv.; 8 ma. 20 cm. f.d. 0.5 mm. Cu	250 e	Single exposure
Krebs (10)	Mouse carcinoma Mouse sarcoma	142 kv.; 2.8 ma. 23 cm. f.d. 0.5 mm. Al	About 6 S.E.D.	Same dose for both tumors <i>in vitro</i> and <i>in situ</i>
Samssonow (19)	Spontaneous mouse tumors	180 kv.; 5 ma. 30 cm. f.d. 8 mm. Al	6,060 r-1,380 r	Doses applied in three sittings, 24-48 hr. intervals
Sugiura (12)	Sarcoma 180	200 kv.; 30 ma. 50 cm. f.d. 0.5 mm. Cu and 1.6 mm. Al	1,800 r in air	Single exposure
Sndelman (20)	Jensen rat sarcoma		4,000-5,000 r in air	Single exposure
Toniolo (15)	Galliera sarcoma	165 kv.; 3 ma. 23 cm. f.d. 3 mm. Al and 0.5 mm. Cu	3,500 r in air	Single exposure
Oughterson et al. (21)	Yale mouse carcinoma	90 kv.; 4 ma. 23.5 cm. f.d. No filter	5,000 r in air	Single exposure
Reinhard and Warner (22)	db. B	200 kv. 30 cm. f.d. 5 mm. Cu	1,500 r in air	Single exposure
Goldfeder	Mouse adenocarcinoma 755	200 kv.; 20 ma. 0.5 mm. Cu and 1 mm. Al	5,500 r in air	Eleven exposures

and V. As can be seen from these tables, there is an apparent quantitative disagreement as to lethal dosages among various investigators. This holds true particularly in the earlier investigations, before the standard r was adopted. The different technical procedures applied are also a factor influencing the final results. In view of the lack of a basis for comparison, no general conclusions can be drawn regarding the relative merits of the various results obtained. The only close agreement is between the results recorded in this paper and those obtained by the Yale group,

which includes Oughterson (21) and Lawrence (13) and their associates. Lawrence and his associates found that a dose of 4,000 r in air was required to prevent an implant from producing a tumor, while Oughterson, using the same inbred strain of animals ("A" albino) and a similar type of tumor of known genetic constitution, found that a dose of 5,000 r in air caused regression *in situ*. As recorded in the present paper (Tables I and II), the dose required to prevent implants of carcinoma 755 from producing a tumor in an inbred strain of mice (C57 "Y") which has a high

incidence of spontaneous mammary carcinoma, lies between 4,300 and 4,500 r in air; tumors of the same type irradiated *in situ* regressed following a total dose of 5,500 r in air applied fractionally. Inasmuch as the experimental procedures of the Yale investigators differ only slightly from those in the present study, and since the final observations are similar, it would seem reasonable to postulate that similar types of tumors, of known genetic constitution, grown in an inbred strain of mice, require similar doses of radiation in treatment.

Another point of interest is the fact that the dose of x-rays necessary to prevent an implant from producing a tumor does not differ widely from that required to destroy a tumor *in situ* when an inbred strain of mice is used. In connection with these observations it may be noted that Sugiura (12) found the dose of radiation required to destroy mouse sarcoma 180 *in vivo* to be about one half that required to inhibit the growth of implants of the same type of tumor. Sugiura, however, used hybrid mice in his experiments. Oughterson *et al.*, using a transplantable mammary carcinoma, showed "1.0 per cent cure with 2,500 r in air and 48 per cent cure with 5,000 r in air. Similar irradiation of the same tumor in hybrid mice showed 82 per cent and 97 per cent cures, respectively." The observations made by Oughterson and his associates and those presented in this paper suggest that quantitatively similar results are obtained from experiments carried out *in vivo* and *in vitro* in which a tumor of known genetic constitution and an inbred strain of mice are used. If it is true that tumors grown in hybrids require smaller dosages than those grown in inbred strains, this represents an advantage for the therapy of cancer in man, inasmuch as here we are dealing exclusively with hybrids.

As to the problem of inducing "immunity" to mammary mouse carcinoma 755, more extensive experimentation is required than could be accomplished with the available supply of the particular

strain of mice at this time.<sup>4</sup> The lethal dose for the tumor implants having been determined, the next step will be to find the threshold dose for the attenuation of the implants to a point at which they will produce no tumor but will induce resistance to subsequent viable implants. This method may also permit the classification of those tumors which do and which do not produce resistance to malignant growth in animals and possibly throw some light on the relation between the genetic constitution of the host and the immunizing capacity of the tumor implants.

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# EDITORIAL

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## Presidential Address<sup>1</sup>

The By-laws of the Radiological Society of North America stipulate that the President of the Society deliver an address at the Annual Meeting. In my effort to abide by this provision, I shall not attempt to enter into any scientific discussion, as others better qualified have contributed to the scientific program presented in the various sessions of the Assembly.

Wartime conditions and patriotic motives resulted in the cancellation of the meetings of the American Roentgen Ray Society and the Radiological Society of North America in 1943. The wisdom of that course is not now questioned, though at the time there were many who expressed disappointment and regret. Early in this year, it became evident to the officers and committees of both societies that cancellation or postponement of our Annual Meetings in 1944 would be most unfortunate and might result in justifiable protest from the members. Realizing these sentiments, each society had originally planned to conduct its Annual Meeting, as in the past. By a most fortunate circumstance, officers and some members of committees of the two groups were in Chicago in February of this year, attending the Annual Meeting of the American College of Radiology. At the instigation of several of the officers, an informal discussion resulted in the suggestion that the two societies meet in joint session. There were many advantages evident if such an arrangement could be accomplished. The announcement of a proposed Joint Meeting was enthusiastically received and gave immediate as-

urance of the desirability and popularity of such a departure from the established custom.

The session in which we are now engaged may quite correctly be designated as a "Wartime Congress of American Radiologists." Invitations have been extended to our colleagues in Cuba, Mexico, Central and South America, and we are happy to welcome some of our fellow radiologists from these neighboring countries. Many who are unable to attend have extended greetings and expressed regrets because of their enforced absence. We are particularly honored and delighted to have with us so many members and guests wearing the Service uniforms of the United States and Canada. The importance of roentgenology in our military activities is evident by the many papers and exhibits dealing primarily with our specialty as applied to the various branches of military medicine.

The world-wide struggle in which we find our country engaged has caused many of our members to enlist in the Medical Services of the Army and Navy. I need not remind you of their splendid record of accomplishment. They have contributed their talent and energy, patriotically and unselfishly, to the successful prosecution of our war effort, which at the moment appears to be nearing completion in the European theater.

Many of our members who desired to enter the military service were disqualified for physical reasons; others were needed to

<sup>1</sup> Delivered before the Radiological Society of North America at its Annual Meeting, in conjunction with the American Roentgen Ray Society, Chicago, Ill., Sept. 27, 1944.



carry on teaching activities and care for civilian practice. When it became necessary to develop a large Army to meet our military requirements, it also became necessary to develop a medical personnel of proportionate size. Early in these developments, it became evident that the need for military roentgenologists could not be met by the number of trained men available. It seemed desirable, therefore, to give intensive training to a group of qualified physicians who, although they had no previous experience in radiology, were selected by the Army officers to enroll in a special short-term training program. The manner in which this perplexing problem was solved has been ably discussed by Col. B. R. Kirklin, in his address before the opening assembly of the meeting. The splendid results accomplished by the intensive training given to this selected group with little, if any, previous experience in roentgenology merit our sincere appreciation and commendation.

Col. A. A. deLorimier, Commandant of the Army School of Roentgenology, has been in charge of the organization and execution of the emergency training program. The subjects covered have been carefully selected, and the curriculum, as outlined by Colonel deLorimier, would indicate that those who successfully completed the course obtained a very excellent fundamental knowledge of roentgenology.

Approximately 825 have completed the course and are now serving in various Army stations, hospitals and outposts, wherever possible under the supervision of well trained and qualified roentgenologists. At the completion of the course, a questionnaire is submitted to each officer. Most of the questions have to do with suggestions for improvement of the course, but each man is also asked to comment on post-war plans. About one-third of the group have indicated their intention of continuing in radiology. The remainder expressed a preference to return to practice in other fields of medicine. Many of the latter group, entirely unsolicited, expressed the opinion that the course had provided an insight

into the science of radiology that was most advantageous and indicated, furthermore, that through their training they had acquired a more sympathetic understanding of the manner of referring cases and how to co-operate more intelligently with the roentgenologist.

Colonel deLorimier makes this interesting personal observation: "I do have the opinion that the scientific viewpoint, emphasizing diagnostic criteria rather than picture impressions, is not ordinarily impressed upon the medical student. Too many of the doctors who have come to this school seem to think that the roentgenologist merely looks at a film and gives an overall impression of the case."

One of the chief topics of discussion today has to do with post-war planning. In an effort to acquire some insight into these discussions as they occur in groups of Medical Service men, a number of officers were consulted directly and indirectly. Their comments regarding present and future conditions in medical fields should be of interest and importance to us.

It is immediately apparent that all of those who have been questioned, whether in the United States or in foreign service, are agreed on one point—namely, that they are unequivocally opposed to any form of Federal-controlled medicine, and they are, furthermore, particularly concerned by the inroads being made and attempted by those agencies whose avowed or implied purpose it is to socialize medicine. These men are in most instances well aware of the measures that have been taken by those physicians who are guarding the home front to prevent such an occurrence, but they are frankly concerned about the apparent apathy of some of their colleagues. One group of officers stated that, in their opinion, organized medicine, particularly the parent organization, as well as some state and county societies, has not been entirely representative or democratic.

There also exists the impression that conditions within some branches of organized medicine are comparable in many ways to conditions prevalent in certain

non-medical groups, where the wishes of the rank and file are disregarded. A plea is made for a more equitable form of medical policy-making and the elimination of certain bureaucratic tendencies within medical ranks.

Quite obviously, such discussions are evidences of what medical men in our Armed Forces are thinking about, and give every indication that we, as physicians, no matter what our specialty, must devote serious thought to some problems that will certainly confront us in the very near future.

American resourcefulness, ingenuity, determination, and ability, coupled with superior scientific attainments, have been the predominating factors in the prosecution of our war efforts, which give every indication of the early subjugation of our adversaries. We share with others a justifiable pride in the part which radiology has taken in these accomplishments. These men of medicine, our colleagues, who have made such valuable contributions, surely deserve every consideration in the readjustment which will inevitably ensue after peace is assured. Obviously, such readjustment is of prime importance to all of us, whether we have participated in military or civilian activities during the war.

For purposes of this discussion, radiologists in all the branches of the Service may be placed in three groups: (1) those who were recognized and established radiologists before entering military service; (2) those with partial training, such as interns and residents in qualified hospitals, as well as those who had partial training in private practice; (3) those who had no previous training in radiology but who, through available military facilities, have been given intensive specialized training and have had varying degrees of actual experience and wish to continue in this field.

In the first group are many of our leading radiologists who, in most instances, were well established in hospital or private practice at the time they entered military service. Undoubtedly, a number of these vacated positions in industry or on hos-

pital staffs. Every consideration should be given to the restoration of the pre-war status of this group, with the utmost regard for their military attainments. Demotions or replacements on hospital staffs without justifiable reason should be vigorously opposed.

The second group, namely those who were partially trained in radiology—our seniors and residents—have undoubtedly acquired considerable experience in military radiology and should be given due recognition if they elect to resume their pre-war status. Many of this group will now be qualified to enter private practice, and these should be given guidance and assistance in obtaining suitable locations or associations. We believe it should be the function of established radiologists to assume this obligation. We agree with Colonel Kirklin's opinion that due consideration should be given these men for the time they have spent in military service, as it applies to a continuation of hospital training and the requirements of the American Board of Radiology.

The third group, or those who have attended the intensive course of instruction and have subsequently been assigned to duty in some phase of military roentgenology, cannot be disregarded in our post-war planning. Their rather rapidly acquired knowledge of radiology has stimulated their interest in our specialty, and a considerable number (about one-third) will elect to remain in its practice. This group has had no experience in the civilian phases of roentgenology and, obviously, will require further training if they are to qualify for certification by the American Board of Radiology.

There is every indication that the number of available trainees, as well as qualified radiologists, will not be adequate to meet our civilian needs for some time after the war. We are informed that, because of draft requirements, the number of pre-medical students is insufficient to provide the usual quota of medical students for some time. That this situation is known to our medical educators is demonstrated

by the support given the Miller Bill, HR No. 5128, which would provide for deferment of approximately 6,000 pre-medical students annually. It is obvious that we must probably look to other sources for our supply of interns and residents. May we suggest that, when possible, we create opportunities for those of the third group, mentioned above, who are qualified and desire to continue their training, by accepting them as seniors and residents. Such an arrangement might be mutually advantageous.

Economics and hospital relationships are subjects which still attract our attention and will certainly be accentuated in the post-war period. You are well aware that, even though radiologists are physicians—licensed and authorized to practise medicine—radiology has not always been recognized as the practice of medicine. An attempt has been made by certain proponents of the Blue Cross Insurance plan to differentiate between technical and professional services. The pernicious and far-reaching influence of such a division would be most disastrous. Efforts of influential radiologists and others who are cognizant of the dangers of such an arrangement have thus far succeeded in preventing this proposed division, but rest assured that, if we relax our vigilance, some unscrupulous insurance salesman will surely be ready to amplify his insurance scheme by selling to policyholders a ticket for x-ray pictures under the guise of competent ethical roentgenological examinations. In this regard, our objective is not one of economics but rather the principles of practice whereby, in all plans for distribution of health service, the radiologists be treated as self-employed physicians.

The proper teaching of physics, particularly as applied to therapeutic radiology, has apparently not received adequate attention in the past. Our physicists are constantly stressing the necessity of more concentrated efforts along this line. This is particularly important in view of the very rapid progress being made in the development of mechanical devices and radioactive

therapeutic agents. We believe that provision should be made whereby necessary facilities will become available for the teaching of physics in institutions otherwise qualified to train resident radiologists. This need not require a full-time physicist, but certainly there should be an arrangement whereby the services of a physicist on a part-time basis could be obtained for this purpose.

Another item to which our attention has been directed has to do with the Army- and Navy-trained x-ray technicians. It is estimated that several thousand enlisted men have been trained for this particular purpose, and a portion of these have acquired a great deal of actual experience. It is obvious, of course, that not all of them will wish to continue this activity, but certainly more men will be available than can possibly be utilized in civilian practice. Undoubtedly, industry will absorb some of these, but it is not apparent at this time what disposition can be made by radiologists of those who, prior to the war, had no radiological training but may desire to continue their war-time training and activities.

You are, undoubtedly, all aware that recently a bill has been introduced in the Congress of the United States whereby x-ray technicians would become eligible for commissions in the Army. The merits of such a measure should be most carefully evaluated before receiving the support of our national radiological organizations.

We have touched briefly on some of the matters that will require our careful attention in any post-war planning which we may consider or undertake.

Quite a number of medical societies—local, state, and national—believe they have a very definite responsibility in this regard, and have appointed committees to study these problems and make recommendations. It would seem desirable that we, as radiologists, recognize our responsibility as it pertains to our specialty. May we, therefore, suggest to the incoming officers that this function be undertaken at the earliest possible time and, if necessary, a

special coordinating committee, representing all the societies, be appointed to act in the best interests of all concerned.

We, as radiologists, enjoy the rich heritage of nearly a half-century of unparalleled progress and scientific accomplishment. The incomparable vigor of this, the youngest specialty in medicine, is a lasting tribute to those pioneers who, although only vaguely visualizing the possibilities of radiology, builded well the foundation thereof.

The rapid progress which has been made in the development and application of radiology in the diagnosis and treatment of disease during the past two decades is, indeed, an enviable record. The introduction of such procedures as bronchography, encephalography, myelography, intrave-

nous urography—to mention but a few of the more recent discoveries—has opened new vistas for our diagnostic and therapeutic armamentarium which have almost limitless possibility.

Science is the predominating factor in the winning of this war, and science will also play a most important role in the era of peace. As a result of military experience, we may expect many new and startling developments in the field of diagnostic and therapeutic radiology.

In closing, may I urge that all members give their support to the officers whose duty it shall become to guide our destiny through the interesting years which lie before us. If we all accept the responsibility which is ours, our progress cannot be impeded.

E. R. WITWER, M.D.

## Leo G. Rigler, M.D.—An Appreciation

Over one hundred friends of Leo G. Rigler gathered at a special dinner in Minneapolis, Dec. 9, 1944, to wish him well. The occasion was the fall meeting of the Minnesota Radiological Society, and the guest speaker was Fred J. Hodges, Professor of Roentgenology, University of Michigan, Ann Arbor. Walter J. Ude, representing the Minnesota Radiological Society and friends of the honored guest, gave a sum of \$10,000 to the University of Minnesota to establish the Leo G. Rigler Lectureship in Radiology. This was accepted by Dean H. S. Diehl. Speakers were Robert G. Allison, George E. Fahr, E. T. Bell, and others. For some time the radiologists have wanted to express to Doctor Rigler their appreciation of his untiring efforts in their behalf. When his friends in other branches of medicine heard of this proposal, they too wanted to help, and the sum accumulated so rapidly that it quickly reached the desired amount.

Leo George Rigler was born Oct. 6, 1896, in Minneapolis. He attended the University of Minnesota, from which he

received his M.D. in 1920. Following an internship in St. Louis City Hospital, St. Louis, Missouri, and practice in North Dakota, he was named teaching fellow in Internal Medicine, University of Minnesota (1921–22). The following year he was appointed Roentgenologist at Minneapolis General Hospital. He was named Associate Professor of Radiology in the University of Minnesota in 1927, and Professor in 1929. In 1935 he became chief of the department and has served in that capacity to date. In 1930 the State Board of Institutions made him a consultant. In 1941 the Minneapolis General Hospital named him chief of the Department of Roentgenology. Prior to accepting the departmental appointment, Doctor Rigler completed his studies in Europe, spending most of his time with Professor Forssell in Sweden. Here he also learned to speak Swedish.

Doctor Rigler is a member of Alpha Omega Alpha, Sigma Xi, American Medical Association, Hennepin County Medical Society, Minnesota State Medical Asso-

ciation, Minneapolis Academy of Medicine, Minnesota Academy of Medicine, American Roentgen Ray Society, Radiological Society of North America, Minnesota Radiologic Society, American College of Radiology (fellow), American Association of Thoracic Surgery and the American Association for the Advancement of Science. He is the author of *Outline of Roentgen Diagnosis*, which went into a second edition in 1943, and of many scientific reports. He is active on the Publication Committee for RADIOLOGY.

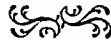
As long as any of us can remember, Leo Rigler has been doing things for other people. The list is long and impressive. He has arranged and organized departmental conferences with most of the other departments in the hospital, as well as with the preclinical branches. He is always ready and willing to speak at medical gatherings and to teach special courses at the Center for Continuation Study. His contributions to graduate training include not only service to members of his own department but service to practically every

other clinical department. He has been instrumental in putting life and vigor into the Minnesota Radiological Society and he has been active in the councils of national associations. In recent years he has made a large contribution to War-Time Graduate Medical Meetings through his visits to all the hospitals in our area. It is at clinical pathological conferences that he is at his best, standing before the group, calling attention to what he sees and giving his conclusions just ahead of the pathologist with his postmortem report. He has been associated with roentgenology during its greatest period of development, and he has made a significant contribution to this specialty.

It is just and fitting that this honor should come to him. The University of Minnesota has been a better place because of his contributions and all of us look forward to profitable years of association with him.

WILLIAM A. O'BRIEN, M.D.

*Director of Post Graduate Medical Education  
University of Minnesota*



## ANNOUNCEMENTS AND BOOK REVIEWS

### AMERICAN COLLEGE OF RADIOLOGY

On Feb. 9, the Commission on Education of the American College of Radiology held a Conference on Post-War Graduate Training for Radiologists, in Chicago. Lt. Comdr. John D. Camp (MC), U.S.N.R., presided, and the speakers were: Victor Johnson, M.D., Secretary, Council on Medical Education and Hospitals, A.M.A.; Lt. Col. Harold C. Lueth, M.C., Liaison Officer, Surgeon General and the American Medical Association; Merrill C. Sosman, M.D., of Boston, and Col. B. R. Kirklin, M.C., Secretary, American Board of Radiology.

### MINNESOTA RADIOLOGICAL SOCIETY

The fall meeting of the Minnesota Radiological Society was held at the Nicollet Hotel, Minneapolis, on Dec. 9, 1944. A scientific session occupied the afternoon, with papers on Radiation Therapy of Mastitis, by Dr. Solveig Berg, X-Ray Treatment of Malignant Tumors of the Testis, by Dr. G. M. Kelvey, and Bone Metabolism, by Dr. Edward Flink. The dinner following this session was made the occasion for paying honor to Dr. Leo J. Rigler and for presenting to the University of Minnesota a fund for the establishment of the Leo J. Rigler Lectureship in Radiology. Dr. Fred J. Hodges of the University of Michigan inaugurated the series of lectures, speaking on The Teaching of Radiology. A fuller account of this honor to Doctor Rigler appears on another page.

### FRANCIS CARTER WOOD, M.D.

#### Fifty Years of Service

On Feb. 14, 1945, the Staff of St. Luke's Hospital, New York City, honored Dr. Francis Carter Wood, Director of the Pathological Laboratories and of the Department of Radiotherapy, at a reception, in recognition of his fifty years of service with the hospital. Addresses in praise of Doctor Wood's contributions to medical science were made by Lincoln Cromwell, president of the hospital, who presided; Dr. John Keating, vice-president of the medical board; Dr. John C. A. Gerster, president of the New York City Cancer Committee, and Dr. Oswald Jones, representing the medical alumni of the hospital. Mrs. Robert G. Meade, on behalf of the New York City Cancer Committee, presented Doctor Wood with a beautiful Paul Revere bowl.

A portrait of Doctor Wood, painted by Leonibel Jacobs at the direction of the hospital's board of managers, was unveiled by Mr. Cromwell and will hang permanently in the library of the hospital.

Doctor Wood has long been active in the affairs of the Radiological Society of North America. He was its president in 1932. He delivered the Carman Lecture in 1939 and in the same year was awarded the Gold Medal of the Society. Its members are

happy at this further recognition of his outstanding services not only to the hospital with which he has so long been associated but to the broader field of medicine and through it to all mankind.

### THREE-YEAR ROTATING SERVICE IN RADIOLOGY

The Peter Bent Brigham Hospital in Boston is announcing a three-year rotating internship and residency in Radiology which began July 1, 1944. The service includes roentgenological training in Pediatrics and Obstetrics under Dr. E. B. D. Neuhauer at the Children's Hospital and Boston Lying-In Hospital, Pathology under Dr. Shields Warren, and Roentgen and Radium Therapy under Dr. Joseph H. Marks, both at the Deaconess Hospital. The initial six months and the final year of the combined service will be spent at the Peter Bent Brigham Hospital under Dr. Merrill Sosman. In individual cases where the candidate has had a thorough training in pathology before starting this service, special arrangements can be made for study and original work in radiation physics, nuclear physics, or biophysics with radioactive tracers, either at Harvard University or Massachusetts Institute of Technology. As soon as Procurement and Assignment will permit, two men will be accepted each year, one each on Jan. 1 and July 1.

This combination of men and of hospital departments should do much to improve the basic training in Radiology and should help insure a continued output of well grounded young roentgenologists, for whom there is such a demand. The plans permit expansion to accommodate returning Service men who may desire shorter periods of training or review in parts of the field, as well as those who wish to complete training previously begun.

## In Memoriam

It is with regret that we record the deaths of the following members of the Radiological Society of North America;

JOHN DEAN BOYLAN, M.D.

Milford Center, Ohio

Nov. 19, 1944

RALPH MAURICE DEGRAFF, M.D.

Buffalo, N. Y.

Dec. 13, 1944

HERMAN GUSTAVE MAUL, M.D.

Denver, Col.

Aug. 13, 1944

ARCHIBALD WILLIAM THOMPSON, M.D.

Buffalo, N. Y.

Oct. 22, 1944

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE FOETAL CIRCULATION AND CARDIOVASCULAR SYSTEM, AND THE CHANGES THAT THEY UNDERGO AT BIRTH. By ALFRED E. BARCLAY, O.B.E., D.M., F.R.C.P., F.F.R., F.A.C.R., KENNETH J. FRANKLIN, D.M., F.R.C.P., AND MARJORIE M. L. PRICHARD, M.A., of the Nuffield Institute for

Medical Research, Oxford. A volume of 275 pages, with 160 illustrations. Published by Blackwell Scientific Publications, Ltd. 48 Broad Street, Oxford. Price 50/-net.

WHAT ARE COSMIC RAYS? Revised and Enlarged American Edition. By PIERRE AUGUR, Professor at the Ecole Supérieure Normale, France, Research Associate in Physics, University of Chicago, Fellow of the American Physical Society. Translated from the French by Maurice M. Shapiro. A volume of 128 pages, with numerous photographs. Published by The University of Chicago Press, Chicago. Price \$2.00.





# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 p.m., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsnr, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*St. Louis Society of Radiologists.*—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 p.m. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Lcvne, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radio logical Society of New Jersey.*—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Lataué Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave. Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—General Secretary, Origène Du-fresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## THE HEAD AND NECK

**Tuberous Sclerosis.** Maurice D. Sachs and Donald A. Shaskan. *Am. J. Roentgenol.* 52: 35-39, July 1944.

Tuberous sclerosis is a rare hereditary disease of ectodermal origin. Cardinal symptoms are (1) retarded mental development; (2) epileptic seizures; (3) adenoma sebaceum; (4) nodules in the brain with a tendency toward cotton ball calcification, and (5) phacoma of the retina. There may be, also, multiple skin nodules similar to those of neurofibromatosis, periungual tumors, rhabdomyoma of the heart, tumors of visceral organs, and high and narrow or cleft palate. The patient seeks medical advice chiefly because of epileptic seizures. These generally have their onset in the first year of life. Mental deterioration is progressive. There is a symmetrical butterfly distribution of small warty tumors over the nose, cheeks, and chin. Tumors of the retina appear as small, flat, round, white or yellowish spots on the posterior fundus near the papilla.

Roentgenologically, multiple circular nodules of increased density with varying degrees of calcification are seen throughout the brain. Pneumo-encephalograms may reveal the classical "candle guttering or dripping" as a result of indentation of the ventricular system by the nodules. Hydrocephalus may be a pertinent finding. Erosions of the clinoid processes and sphenoid wings as well as hyperostosis interna have been reported. Cysts in the spongiosa of small bones have been described. Renal tumors are common. Polyposis of the colon may also be present.

The diagnosis of tuberous sclerosis should be considered in every patient with mental retardation and epilepsy, especially in association with adenoma sebaceum. The authors present a case with many of the findings described in the text.

CLARENCE E. WEAVER, M.D.

**Cholesteatoma of the Petrous Bone.** Joe Pennybacker. *Brit. J. Surg.* 32: 75-78, July 1944.

Progressive paralysis of the facial nerve may be caused by a tumor in the cerebellopontine angle or by pressure on the nerve in its course through the petrous bone. Three cases of the latter type are reported in which the pressure was found to be due to a cholesteatoma in the petrous bone.

The first patient was a man aged 42 with a complete right facial paralysis developing over a period of eighteen months. There was impairment of sense of taste on the right side and the patient was very deaf in the right ear. The caloric responses were absent on the right side and normal on the left. Roentgenograms of the skull showed an erosion of the upper surface of the petrous bone medial to the mastoid antrum. The mastoid air cells were of about normal translucency. At operation an irregularly oval erosion in the petrous bone anterior to the arcuate eminence was found. The defect was filled with a soft cheesy white material. The facial nerve was exposed and found to be intact but flattened. The patient was observed for two and a half years following operation and there had been no improvement in the facial palsy or deafness.

The second case was in a man of sixty who had had a discharging left ear in childhood with resulting deaf-

ness in that ear, although there had been no recurrence of the discharge. Gross spasmodic contractions of the left facial musculature began one year before hospital admission, and complete facial paralysis occurred three months before. The radiologic findings were similar to those in the first case and a similar lesion was found at operation. After six months there was definite evidence of recovery and this had continued until the patient was able to innervate the whole of the left side of his face.

The third patient was a man of 53 with a facial palsy of four years' duration. He gave a history of otitis media twenty-five years before, followed by complete recovery. Roentgenograms showed an erosion of the superior surface of the petrous bone. The neurological findings were similar to those of the other two cases, and at operation a similar lesion was found. Recovery was not considered likely in this case.

These three cases present many common features. In each there were deafness of the homolateral ear, absence of caloric responses, and impairment of the sense of taste. Roentgenographic and pathological findings were the same in all. The gross and microscopic pathological findings were characteristic of cholesteatoma.

Jefferson and Smalley (*J. Laryng. & Otol.* 53:417, 1938) reported 6 similar cases and found references to 5 others in the literature of the previous twenty-five years. They considered the tumors to be epidermoids of the embryonal inclusion type rather than the cholesteatoma often associated with chronic mastoid infection. In at least 2 of their cases there had never been any aural infection, and in the others the infection was remote and trivial in degree. The question whether cholesteatoma causes infection of the middle ear and mastoid or is itself the product of chronic inflammation has not been answered at this time.

The best chance for recovery in these cases rests in early operation and subsequent electrical treatment.

MAX CLIMAN, M.D.

**Tomography of the Temporo-Mandibular Joint and Ramus of the Mandible.** C. W. C. Gough. *Brit. J. Radiol.* 17: 213-215, July 1944.

Tomography is the only method of showing the temporomandibular joint and the ramus of the mandible without distortion. It is particularly useful to the plastic surgeon in congenital facial asymmetry, fibrous and bony ankylosis, and in traumatic lesions. Brief case reports are included, with illustrations.

SYDNEY J. HAWLEY, M.D.

**Foreign Body in the Thyroid Gland.** Herbert T. Wikle and Thomas Spellman. *Surgery* 15: 994-996, June 1944.

The authors report a case of foreign body in the thyroid gland present for a long period without causing any reaction that could be specifically referred to it. The patient, a 38-year-old white woman, complained of a tumor of the anterior portion of the neck first observed at the age of twelve. This was twice operated upon when the patient was fifteen. Some diminution in size followed, but five years later the growth began

to enlarge and had continued to do so until the present admission (1938).

The patient complained of moderate orthopnea and dyspnea on exertion. There were no symptoms of thyrotoxicosis or exophthalmos. A large thyroid tumor, the size of a grapefruit, filled the entire anterior part of the neck and extended on both sides into the posterior triangle. The tumor was firm and showed several nodules. There was slight cardiac enlargement and a loud systolic murmur. The basal metabolic rate was plus 13 and the electrocardiogram was essentially negative. A roentgenogram showed the lungs to be clear and the cardiac enlargement was interpreted as hypertrophy and dilatation.

A lateral examination of the neck showed a large soft-tissue opacity in front of the trachea, measuring 8 cm. in the antero-posterior diameter and 14.5 cm. in transverse diameter. A few small specks of greater density scattered throughout the mass were believed to represent cartilaginous change.

Six days after admission a subtotal thyroidectomy was performed. A large amount of scar tissue was encountered on both sides, adjacent to the previous operative scars. A portion of the left lobe was found to extend retrosternally. After this was delivered into the wound a sharp object was palpated in the fascia, just below the suprasternal notch. This was removed and found to be an old cutting edge needle in two parts, the major one 1.5 cm. in length. It is interesting to note that the needle was discovered just below the suprasternal notch, yet the two operative scars were in the mid portion of the neck on either side.

J. E. WHITELEATHER, M.D.

## THE CHEST

**Incidence of Pulmonary Tuberculosis in the Royal Canadian Navy.** Carleton B. Peirce, G. Jarry, and Alan C. Richardson. *Canad. M. A. J.* 51: 46-51, July 1944.

As an assay of the effectiveness of the "screening" methods in use, and to determine, if possible, the influence of service conditions, a survey was made of tuberculosis in the Canadian Naval Service from September 1939 to December 1943. Of 82,946 recruits examined in this period, 8,398 (10.1 per cent) were rejected for all causes. Pulmonary tuberculosis accounted for 439 rejections, 0.53 per cent of the total number examined and 5.2 per cent of all those rejected. The number of cases of tuberculosis discovered in the Naval Service during this same interval was 151, or 0.8 per thousand per year, an over-all rate of 2 per thousand, since the total naval strength was 75,354 (as of Jan. 1, 1944). The greatest incidence was in the first two years, due probably to incompleteness of the radiographic survey prior to the institution of compulsory mass radiography.

On an occupational basis, the incidence was highest among writers and supply ratings (19 cases, or 7.4 per 1,000) and cooks and stewards (17 cases, or 4.6 per 1,000). The engine room personnel showed a rate almost double that of those on deck, 2.9 per 1,000 compared with 1.7 per 1,000.

The highest rate of discharge for tuberculosis was in the second year of service, but in men on sea duty the incidence of the disease increased with the length of service at sea.

Only two deaths occurred in this series, both from

meningitis. Analysis shows that 62 per cent of the 151 cases were detected when the lesions were minimal or sub-minimal, 31 per cent when moderately advanced, and 7 per cent when far advanced. Twenty-one per cent of the series were under twenty years of age and 45 per cent were between twenty-one and twenty-five years.

Pulmonary tuberculosis had been the sixth cause for invaliding from the service up until January 1944. It is exceeded by mental and nervous disorders, eye diseases, peptic ulcers, and respiratory infections other than tuberculosis.

The authors state a preference for the use of conventional 14 X 17-in. film in mass chest surveys. They believe that accuracy in interpretation and the availability of a large film for future possible comparative examination outweigh the economy of cost and filing space afforded by miniature films.

LESTER M. J. FREEDMAN, M.D.

**Comparison of Roentgenograms with the Pathology of Experimental Miliary Pulmonary Tuberculosis in the Rabbit.** E. M. Medlar, G. S. Pesquera, and W. H. Ordway. *Am. Rev. Tuberc.* 50: 1-23, July 1944.

It has been shown previously that miliary tuberculosis in the rabbit can be produced consistently by intravenous injection of bovine bacilli. The number of lesions can be controlled to some extent by the number of bacilli injected. The course of the infection depends upon whether virulent or non-virulent strains have been used, whether or not the animals are vaccinated, and whether a large or small dosage of virulent bacilli is given. With this knowledge at hand, the series of experiments reported in this paper was undertaken, in order to make a comparative study of the pathological findings and of roentgenograms of the thorax and of inflated excised lungs in miliary pulmonary tuberculosis.

As would be expected, the extent and essential nature of the pathological lesions were best determined by microscopic examination. To a lesser degree the pathological findings were demonstrable in macroscopic examination, roentgenograms of the excised lungs, and, lastly, roentgenograms of the thorax of the living animal. The latter failed to distinguish between primary infections with virulent and non-virulent bacilli or between primary infection and reinfection with virulent bacilli. In general the various types of pathological processes could not be differentiated roentgenographically in the excised lungs except for compact calcium deposits. Lesser amounts of calcium within caseous foci could not be differentiated from the caseous material. Superimposition of lesions caused a density in shadows which masked their true nature. Compactness rather than size appeared to be the determining factor as to whether a given lesion could be visualized, and the compact lesion needed to be equal to at least the volume of a primary lobule before a shadow would be cast in roentgenograms of the excised lung. It would appear that considerably larger areas of compact, inflammatory exudate would be necessary before their shadows could be seen in roentgenograms of the thorax.

If these facts are applicable to the human chest, it is probable that the earliest demonstrable tuberculous focus would be a compact area of tuberculous bronchopneumonia.

L. W. PAUL, M. D.

**Massive Pulmonary Atelectasis Occurring During Primary Tuberculous Infection.** Gustavo Cardelle, Francisco Borges, and Raul Perciras. *Bol. Soc. cubana de pediat.* 16: 85-93, March 1944.

A case of massive pulmonary atelectasis developing in a child with primary tuberculosis is reported.

The patient, a nineteen-month-old boy of healthy parents, but with a tuberculous grandmother, had frequent colds, cervical adenitis, otitis, and tonsillitis. Complaints on admission were continued temperature rise, cough, and dyspnea. The child was poorly nourished but showed no signs of serious illness.

The cervical lymph nodes were very large, and the axillary and inguinal nodes also showed some enlargement. X-ray examination revealed massive collapse of the left lung, as well as enlarged mediastinal nodes. Bronchoscopic examination showed the mucosa in the left bronchus to be inflamed, with much thick yellow phlegm obstructing the lumen.

In discussing the differential diagnosis, the authors state that the condition offering the greatest difficulty is fibrosis, in which the lung is retracted and the mediastinum is displaced to the affected side. Pneumothorax and fluoroscopy are important aids.

The value of artificial pneumothorax in the treatment of this type of atelectasis is stressed.

A. MAYORAL, M.D.

**Pneumonia, Pneumothorax, and Emphysema Following Ingestion of Kerosene.** Edwin Paul Scott. *J. Pediat.* 25: 31-34, July 1944.

Pulmonary manifestations following the accidental ingestion of kerosene are rather common in young children. In the case reported, pneumonia, pneumothorax, and emphysema of the soft tissues of the chest were the complicating factors.

A 2-year-old child was admitted to the hospital in a comatose condition about two hours after the ingestion of 1 to 2 ounces of kerosene. Numerous moist râles were heard throughout the lung fields, with no demonstrable change in the percussion note. The abdomen showed considerable distention. The rectal temperature was 99.6° F., with a respiratory rate of 48 per minute. The patient responded well to treatment and the following morning was alert and ate well. In view of an elevation of the temperature to 103.2° and an increased white blood cell count, sulfathiazole was administered. Two days later the temperature became normal. At this time examination of the chest revealed emphysema of the soft tissues of the neck and chest and numerous fine crepitant râles throughout the lung fields. Roentgen studies the following day showed a left pneumothorax with partial collapse of the left lower lobe. The entire left lung showed a dense, patchy, hazy process, especially pronounced in the lower lobe. On the right there was an irregular haze except in the cardiophrenic sinus, where consolidation was present. Overlaying this region was an area of decreased density which measured 3 cm. and apparently represented a fluid level. The heart was slightly enlarged and displaced to the right. An extensive soft-tissue emphysema was present over the upper abdomen and thorax, extending to the neck and face.

The pneumothorax gradually cleared and the emphysema disappeared. Two weeks following the accident, the physical and roentgen examinations were normal.

**Dust Bronchitis.** John A. Toomey and Carl L. Petersilge. *J. Pediat.* 25: 25-30, July 1944.

A type of bronchitis associated with prolonged exposure to high concentrations of dust, having none of the characteristics of an infectious disease, is described. This bronchitis was correlated with sparsity of rainfall.

During 1941 and 1942, 63 children with coughs were admitted to the infirmary of an orphanage. The patients were healthy and apparently normal. Often the first sign of dust bronchitis was an explosive, intractable, unproductive cough. Subjectively the only complaint was an uncomfortable tickling sensation in the throat accompanied by an uncontrollable cough which was aggravated by excitement or by lying on the back. Objectively the patient was comfortable unless activated in some manner. Coughing, once initiated, was severe, sometimes to the point of vomiting. The temperature was slightly elevated, *i.e.*, about 101° F., returning to normal after twenty-four to forty-eight hours' rest in bed.

Inspection, percussion, and palpation of the chest revealed nothing abnormal. On auscultation, loud rhonchi were heard, most commonly over the large bronchi, particularly over the bases, predominating on the left. There were wheezing and whistling noises in the chest, but there were no modifications of inspiratory or expiratory sounds and no fine parenchymatous râles. A deep breath often initiated a coughing spell.

Thirteen of the 63 children had roentgen studies of the chest. The composite picture was described as follows: "There were soft-appearing patchy mottling with increased markings along the course of the bronchi, usually the descending ones. Ulceration, calcification, retraction, or emphysema were not present. The shadows looked not unlike those found in bronchiolitis obliterans, except that the mottling was coarser. This might have been due to the fact that in these children the larger bronchi were involved. The lungs showed no other changes."

Treatment is prophylactic and symptomatic, the former being the most important.

**Loeffler's Syndrome. Transient Pulmonary Infiltrations with Blood Eosinophilia.** H. B. Pirkle and Julia R. Davin. *Am. Rev. Tuberc.* 50: 48-51, July 1944.

Löffler's syndrome (Löffler, W.: *Beitr. z. Klin. d. Tuberk.* 79: 338, 1932) consists of asthma with cough, eosinophilia ranging from 10 to 60 per cent, low-grade fever, mild leukocytosis and an elevated sedimentation rate. Roentgenograms of the chest reveal infiltrations in various parts of the lungs, usually the lower, which disappear rapidly.

A case is presented which differs from others reported in the literature in that there was no asthma and the pulmonary infiltrations were of long duration and migratory in character. The clinical course and the roentgen evidence of disease lasted over a period of nine months, during which time pulmonary infiltrations of varying extent developed. The lesions tended to clear in some areas only to reappear in other parts of the lung fields. The eosinophil count reached as high as 33 per cent. The diagnosis of pulmonary tuberculosis was made at the first examination, but further study eliminated this possibility and likewise failed to establish any other etiologic agent.

L. W. PAUL, M.D.



**New Growths of the Chest.** Carl W. Tempel. *Dis. of Chest* 10: 277-312, July-August 1944.

The author presents his material under four headings. In the introduction he stresses the need of close co-operation on the part of the internist, endoscopist, roentgenologist, pathologist, and surgeon, in the diagnosis and treatment of new growths of the chest. Part two is devoted to classification, and part three to diagnostic criteria, including pathological and roentgen studies, therapeutic doses of roentgen radiation, bronchoscopy and esophagoscopy, surgical exploration, laboratory tests, thoracoscopy, symptoms and signs of diagnostic importance. Part four consists of case histories with illustrations.

The main subdivisions of the author's classification are as follows.

1. Tumors of the large or major bronchi
  - A. Carcinomas: squamous-cell and small-cell types
  - B. Adenomas (mixed tumors)
2. Tumors of minor bronchi or periphery of the lung
  - A. Adenocarcinoma
  - B. Superior pulmonary sulcus tumor
3. Anterior mediastinal tumors
  - A. Malignant lymphomas: lymphosarcoma; Hodgkin's disease; leukemia; giant follicular lymphocytoma
  - B. Thymomas
  - C. Teratoid tumors
  - D. Cysts
4. Posterior mediastinal tumors: Primary neuromas
5. Rare mediastinal tumors
  - A. Fibroma and sarcoma
  - B. Carcinoma
  - C. Tumors arising from bone and cartilage
  - D. Intrathoracic cysts of intestinal structures and intrathoracic stomach
  - E. Lipomas
  - F. Xanthomas
6. Tumors originating in chest wall
  - A. Benign tumors
  - B. Malignant tumors
  - C. Tumors of pleura
7. Non-neoplastic lesions, which may be confused with new growths
  - A. Cysts: congenital; developmental; acquired inflammatory; echinococci
  - B. Circumscribed inflammatory masses within the lung
  - C. Lymph node enlargement: solid or abscessed masses of tuberculous hilar or mediastinal lymph nodes; Boeck's sarcoid; benign enlargement of unknown etiology
  - D. Atelectasis of a lobe or part of a lobe
  - E. Aneurysms of the great vessels and heart
  - F. Lesions of the diaphragm
  - G. Mega-esophagus
  - H. Encapsulated empyema
  - I. Abscess: mediastinal and Pott's
  - J. Mediastinal thyroids

For diagnostic purposes, all available chest films should be reviewed, and stereoscopic, lateral, and oblique roentgenograms should be made. Most circumscribed intrapulmonary neoplasms are bronchiogenic carcinomas; circumscribed extrapulmonary tumors in the costovertebral region are usually

neurofibromas, and in the anterior chest, teratomas. Most neoplasms that are not well circumscribed are malignant, but the loss of sharp definition at the edge of the tumor may be due to inflammatory changes or atelectasis in the adjacent lung.

The x-ray findings in the majority of bronchiogenic tumors are those of atelectasis or other secondary changes. If a large bronchus is partially obstructed, the lung involved becomes less radiant and is likely to show linear areas of increased density. In the presence of complete obstruction of a secondary bronchus, the collapsed portion of the lung usually appears as a dense triangular area along the diaphragm, heart, and spine. With complete occlusion of the right or left main bronchus, the entire half of the chest is extremely dense; the mediastinum is displaced into the involved lung field; the intercostal spaces are narrowed, and the diaphragm is elevated.

Diagnostic pneumothorax may aid in distinguishing between tumors of the lung, mediastinum, and thoracic wall. Pneumoperitoneum is of value in differentiating supradiaphragmatic from subdiaphragmatic lesions.

Bronchography with the aid of lipiodol may be used to demonstrate the level and extent of the bronchial occlusion, as well as the condition of the lung beyond the tumor.

Fluoroscopy is of value to determine whether a mass is expansile, as an aneurysm; as an aid in localization of the tumor, and in disclosing its relation to the diaphragm. Tumors in the lower part of the chest not in continuity with the diaphragm will usually descend with the lung during inspiration if they are intrapulmonary. If the diaphragm is paralyzed, it usually means that the phrenic nerve is involved and the case is inoperable.

A favorable response to a therapeutic dose of x-rays indicates the probable presence of a lymphoblastoma.

If it is suspected that the pulmonary tumor is metastatic, appropriate x-ray studies should be undertaken to determine the primary site.

HENRY K. TAYLOR, M.D.

**Cavernous Hemangioma of the Lung (Arteriovenous Fistula).** Report of a Case with Successful Treatment by Pneumonectomy. W. E. Adams, T. F. Thornton, Jr., and Lillian Eichelberger. *Arch. Surg.* 49: 51-58, July 1944.

Cavernous hemangioma of the lung is a rare condition; its association with polycythemia has previously been reported only four times. In this instance a man of twenty-four complained of frequent nosebleeds and colds over a period of two or three years. For at least sixteen years he had a generalized cyanosis and clubbing of the fingers, which were first observed following an attack of influenza at the age of six. He had nevertheless been able to work as a farm laborer. Examination showed an arresting degree of cyanosis, clubbing of the fingers and toes, and small hemangiomas of the lips and face. Breath sounds were somewhat diminished over the whole chest. Other findings were normal. The red cell count was 7,200,000; hemoglobin 23 gm. per 100 c.c. The total blood volume was 12,750 c.c., of which 10,330 c.c. were cells. The vital capacity of the lungs was 3,800 c.c.

Roentgenograms of the chest showed a lobulated shadow covering 25 sq. cm. between the left seventh and

ninth ribs posteriorly. A similar area of density, 1 cm. in diameter, was present in the right mid-axillary line at the level of the sixth rib. The extremities showed deposition of periosteal new bone.

A successful removal of the left lung was performed. One lesion was found to consist of a multiloculated, smoothly lined cavity  $3 \times 4$  cm., which communicated with the pulmonary artery by a vessel 0.5 cm. in diameter and with the vein by one 1 cm. in diameter; two other similar lesions were present in this lung. Microscopic study showed a mesothelial lining on a fibrous connective-tissue wall; there was no hemangiomatous tissue outside the cavities. The pathological diagnosis was multiple arteriovenous fistulas of the lung. Following operation the red cell count fell to 5,000,500 and the hemoglobin to 15.5 gm. per 100 c.c. The blood volume decreased to 6,900 c.c., 4,250 c.c. of which were cells. Other laboratory findings also tended to become more normal. The patient was alive, well, and doing his work for a period of nine months of observation.

While this condition is easily confused clinically with polycythemia vera, clubbing of the fingers and toes should suggest the advisability of a roentgenogram of the chest, which will lead to the correct diagnosis.

LEWIS G. JACOBS, M.D.

**Tuberculoma of the Posterior Mediastinum.** Brian Blades and David J. Dugan. *Am. Rev. Tuberc.* 50: 41-47, July 1944.

An occasional case has been reported in the literature in which a tuberculous or other inflammatory lesion of the lung has been mistaken for tumor and the error discovered only after surgical intervention. These cases represent exceptions, for the great majority of intrapulmonary masses demonstrable on roentgenograms, which cannot be identified by ordinary methods, will prove to be malignant or potentially malignant neoplasms.

A 56-year-old white male complained of slight dyspnea on exertion. Roentgen study disclosed a circumscribed mass in the posterior mediastinum behind the heart. After study, the diagnosis of primary nerve tumor was made and operation was undertaken. The mass was well encapsulated and could be removed without difficulty. Microscopic examination showed the lesion to be a tuberculoma. The patient made an uneventful recovery. This diagnosis had not been considered prior to the examination of the tissue. The results indicate that such an error in diagnosis may be less harmful to the patient than procrastination when dealing with intrathoracic tumors of unknown nature, and that removal of a well encapsulated tuberculous lesion need not be followed by dissemination of the disease.

L. W. PAUL, M.D.

**Observations on the Heart Size of Natives Living at High Altitudes.** A. J. Kerwin. *Am. Heart J.* 28: 69-80, July 1944.

In order to determine the effects of chronic anoxia on the heart, roentgenographic examinations were made of 273 normal native Peruvian males of the Indian race. Their average height was 156.26 cm., and their average weight was 55.63 kg. All were born at altitudes varying from 10,000 to 15,000 feet and, with few exceptions, had lived all their lives at these altitudes.

The transverse, long, and broad diameters were measured, and the frontal area was estimated from the

long and broad diameters by means of the nomogram of Ungerleider and Gubner (*Am. Heart J.* 24: 494, 1942, *Abst. in Radiology* 40: 528, 1943). The estimate of the effect of altitude on heart size was based on the transverse diameter and the frontal area.

The author found that the transverse diameters of the natives were greater than the normal standards for white males in all age groups living at low altitudes, the average difference being +11.5 per cent. The frontal area showed an average increase of 16.3 per cent over the normal for men living at or near sea level. The author believes that chronic anoxia is a reasonable explanation for the increase in the frontal area and the transverse diameter of the heart.

HENRY K. TAYLOR, M.D.

**Cardiac Aneurysm.** Percy J. Delano and Arthur R. Weihe. *Am. J. Roentgenol.* 52: 31-34, July 1944.

Almost all cardiac aneurysms are due to coronary thrombosis; among the other very occasional causes must be listed abscess of the cardiac wall, trauma, ulcerative endocardial lesions, and congenital lesions. Cardiac aneurysm may be found as early as six weeks after a coronary occlusion. The usual sequence of events appears to be anemic necrosis and myomalacia, followed by fibrosis. About 85 per cent of these aneurysms occur in the left ventricle; 2 to 5 per cent of them are in the right ventricle. Some are found in the interventricular septum. About 80 per cent occur in males. Syphilis plays a minor role. Rupture of a cardiac aneurysm is rare.

The postero-anterior roentgenogram of the chest gives adequate information in many instances, since most of the aneurysms are situated in the left ventricle. Aneurysms involving the cardiac apex may be elusive unless care is taken to examine this area well in deep inspiration. Roentgenoscopy should be employed. Paradoxical motion in the aneurysmal sac is not a reliable sign as it is often absent. Aneurysms in the apex have a tendency to develop downward.

Death is usually due to another attack of coronary thrombosis. The average life expectancy is a little less than two years.

The authors describe one case of aneurysm of the left ventricle, discovered during examination of the gastro-intestinal tract. The cause was coronary thrombosis.

CLARENCE E. WEAVER, M.D.

**Longevity in Ventricular Aneurysm: Report of a Case Followed over a Ten Year Period.** Dennison Young and John B. Schwedel. *Ann. Int. Med.* 21: 141-149, July 1944.

It is most unusual for a person with a progressively enlarging aneurysm of the left ventricle to continue his daily activity and maintain himself as a useful, productive member of society for a period of ten years, as happened in the case here recorded. The patient was closely followed over this period, clinically, radiographically, and electrocardiographically.

Four months before the patient was seen he began to experience episodes of pain in the epigastrium, chest, and in both upper extremities, with dyspnea, and nausea, following exertion. The attacks became more frequent and severe in character. On first examination (Sept. 24, 1931) the picture of shock was present. The heart was not enlarged to percussion; the first apical sound was faint and a pericardial friction rub was present. The white blood cell count was 18,000,

with 89 per cent polymorphonuclear leukocytes. The electrocardiogram was that of anterior wall infarction.

Roentgen examination on Oct. 13, 1931, revealed an enlargement of the heart to the right and left with a prominence at the mid portion of the left border suggesting the presence of a ventricular bulge. Ten days later this prominence had increased in size. The patient was discharged improved on Nov. 29.

On Jan. 27, 1932, the patient was admitted to Montefiore Hospital. On fluoroscopy the left ventricle was seen to be greatly enlarged and its pulsations were poor. An angular bulge was noted in its upper middle contour. The left auricle was enlarged horizontally. Moderate enlargement of both the outflow and inflow tracts of the right ventricle was present. Four months later there was further enlargement of the left ventricle, especially in the region of the aneurysmal bulge. In the left anterior oblique view an area of increased density was seen to occupy most of the posterior left ventricular contour. This increased density was believed to be due to an organized thrombus within the aneurysmal bulge.

Four months later the patient was again discharged as improved, and for the next nine years he was observed frequently in the adult cardiac clinic. Throughout this period he continued his occupation as a machine operator, working thirty-five hours a week. Symptoms of congestive heart failure reappeared in 1941, and on Sept. 8, 1941, acute severe colicky pain occurred in the right upper quadrant just above and to the right of the umbilicus. The liver enlarged progressively; sibilant râles were heard throughout the lungs, and death ensued (Sept. 10).

Throughout the nine years of observation at Montefiore Hospital, radiographic examination demonstrated progressive enlargement of the ventricular aneurysm.

The autopsy diagnosis was a hypertrophy and dilatation of the heart with arteriosclerosis of the aorta. An extensive arteriosclerosis of the coronary arteries with old occlusion of the left anterior descending and right main coronary arteries, and marked narrowing of the circumflex branch of the left coronary artery, was found. An old healed infarct of the septum and anterior and posterior walls of the left ventricle, with aneurysmal dilatation and mural thrombus formation involving the anterior, lateral, and posterior walls of this chamber, was present.

The aneurysmal bulge involved most of the anterior wall of the left ventricle, the greater part of the interventricular septum, and slightly less than the lower half of the posterior wall, mostly laterally. It measured  $10 \times 8 \times 7$  cm. and was filled with firm lamellated brown and brownish-red thrombus. The entire left ventricular chamber was markedly dilated.

STEPHEN N. TAGER, M.D.

**Coarctation of the Aorta: Clinical and Roentgenologic Analysis of Thirteen Cases.** Lawrence Perlman. *Am. Heart J.* 28: 24-38, July 1944.

Coarctation of the aorta is a congenital anomaly. It may be of the infantile type, occurring in children up to the age of one year, or of the adult type. Routine physical examinations of an unselected group of men for army service showed an incidence of 1:10,000, though postmortem statistics have shown an incidence of 1:1,500 (Blackford: *Arch. Int. Med.* 41: 702, 1928). The discrepancy is attributed to the inclusion of slight narrowing at the site of the ductus arteriosus by the

pathologists in their series, and also to missed clinical diagnoses.

The roentgen examination is a definite aid in diagnosis, the usual findings being absence of the aortic knob, dilatation of the ascending and transverse portions of the aortic arch, erosion of the lower margin of the posterior portions of the ribs, and roundness or enlargement of the left ventricle. In the author's series of 13 cases, absence of the aortic knob and erosion of the ribs were the only constant radiologic findings. In 10 instances the aorta was either slightly or moderately dilated, and in 3 there was no dilatation. Left ventricular hypertrophy was slight in 5, moderate in 3, marked in 1, and absent in 4. Electrocardiograms were made in 7 cases: 5 were normal, and in 2 the findings were compatible with hypertensive heart disease.

HENRY K. TAYLOR, M.D.

## THE DIGESTIVE SYSTEM

**Peptic Ulcer Perforating Into the Anterior Abdominal Wall.** Carl G. Morlock and Waltman Walters. *Am. J. Surg.* 65: 133-137, July 1944.

Three cases are reported of a benign peptic ulcer occurring at the stoma of an anterior gastrojejunostomy. These ulcers became attached to and burrowed deeply into the abdominal wall. In order to attach itself to the anterior abdominal wall and secondarily penetrate it, the ulcer must have its origin in a part of the wall of the stomach adjacent to that of the abdomen. A gastrojejunal ulcer arising on the anterior rim of an anterior gastrojejunal stoma is, therefore, peculiarly likely to result in this complication. When it occurs, it must be treated surgically. For a gastric ulcer to originate in the anterior gastric wall and penetrate into the abdominal wall is exceedingly rare in a stomach which has not been previously disturbed by operation.

**The Normal Distribution of the Small Intestine** Samuel T. Herstone and Seelig Freund. *Am. J. Roentgenol.* 52: 46-51, July 1944.

The authors reviewed the work and results obtained by various investigators of the problem of the normal distribution of the small intestine and found no general agreement. This paper reports a re-investigation of the subject.

Fifty-four cadavers were studied. The habitus of each was determined by tracings of the subcostal angle. The abdomen was divided into five regions; right and left upper quadrants, right and left lower quadrants, and minor pelvis. A loop of small intestine was selected at random from each of the five regions and was identified by tying a colored ligature about it, a different color being used for each region. In five of the cadavers all the loops in each region were identified by colored strings. Schematic drawings of the configuration of the small bowel with particular reference to the five regions were made. The distance of each colored ligature from the duodenojejunal flexure was determined. Five types of grouping of the small intestine loops were found and are described in the text and illustrated by line drawings. No relationship was found between various groups and habitus. The total length of the bowel varied from 10 to 30 feet. The distance of the various colored strings from the duodenojejunal junction showed great variation. For example, the red string, which signified the left lower quadrant, was found to be 2 feet 6 inches from the

duodenojejunal junction in one cadaver and 15 feet from the same point in another. Loops were found lying together which in the outstretched gut were as much as 20 feet apart.

The conclusion is reached that, although definite patterns and groups are recognizable in a study of the small intestine, these are not sufficiently constant to be of any clinical value. It is impossible to predict the distance of a loop from the duodenojejunal junction by its location in the abdomen.

CLARENCE E. WEAVER, M.D.

**Roentgenological Anatomy of the Position of the Coils of the Normal Small Intestine.** F. Y. Khoo, K. S. Liu, and K. H. Ch'en. *Chinese M. J.* 62: 61-82, January-March 1944.

The authors studied the small intestinal pattern of 444 adults, employing a barium meal, and recording the findings from serial fluoroscopic and radiographic observations. They conclude that, with the exception of a relatively constant location for the proximal jejunum and distal ileum, the position of the middle loops of the small gut is so variable that it is not feasible to allocate certain groups specific positions. Their studies also confirm the changeability of the intestinal pattern as seen in the same subject on different days.

ELLWOOD W. GODFREY, M.D.

**Atresia of Small Intestine. Two Case Reports; One Multiple Atresia, with Survival.** William H. Erb and Delbert C. Smith. *Ann. Surg.* 120: 66-72, July 1944.

The authors briefly review the literature and report two additional cases of atresia of the small intestine. This condition is relatively rare, occurring but once in every 20,000 births (Webb and Wangenstein. *Am. J. Dis. Child.* 41: 262, 1931). It results from a failure of recanalization of the intestinal tract following the obliteration of the original lumen by epithelial confluences between the fifth and tenth week of fetal life.

The most valuable laboratory test is a plain film of the abdomen. Distended loops of small bowel and fluid levels may be seen in the erect and head-down positions. If the atresia is of the duodenum or high jejunum, distention may be absent or negligible. Barium by mouth, as a diagnostic aid, is contraindicated, as this may clog the narrow lumen of the distal loop following anastomosis, or lead to bronchopneumonia from aspiration of the vomited barium. Clinically, attention is directed to this condition by persistent vomiting and absence of keratinized epithelium in the meconium.

Emphasis is placed on the necessity of performing a primary anastomosis to prevent loss of intestinal content through an enterostomy. Open-drop ether is used to obtain a quiet operative field. Electrolytic balance should be followed both pre- and postoperatively, and vitamin K should be administered preoperatively to combat hypoprothrombinemia.

ELLWOOD W. GODFREY, M.D.

**Diverticulitis and Diverticulosis.** Norman P. Henderson. *Brit. J. Radiol.* 17: 197-203, July 1944.

Diverticulosis is a herniation of mucosal sacs into or through the bowel wall. Diverticulitis is an inflammation of these herniated sacs, or diverticula.

Diverticula may be congenital or may appear during or after an attack of inflammation of the bowel wall. The inflammation causes fibrosis and allows the mucosa to herniate through local points of weakness particularly at the entrance of nerves and blood vessels. Inflammation is not the only cause of diverticula. They may occur as a result of chronic constipation or in association with some other disease, such as polyposis or carcinoma. The condition is more common in men. It is most frequent in the sigmoid.

Five stages of diverticulosis may be recognized. The first stage shows on the x-ray as a "ripple" pattern at the edge of the bowel. This stage is frequently overlooked or is interpreted as spasm. The second stage shows small projecting "palisades" along the border of the bowel. [Just what is meant by "palisades" is not clear to the abstractor.] In the third stage small protruding pulsion diverticula are demonstrable. At this stage, these are retractable. In the fourth stage, which the author designates as "retractable ballooning," large retractable diverticula are seen. The fifth stage is that of permanent diverticula.

Sometimes diverticulosis is the first sign of cancer of the colon. Two illustrative cases are reported.

The disease may heal completely in any one of the first three stages. Fibrosing diverticulitis may follow the last stage, when inflammation occurs in the permanent diverticula. SYDNEY J. HAWLEY, M.D.

**Cholecystography with Beta(4-Hydroxy-3,5-Diiodophenyl) Alpha Phenyl Propionic Acid.** Harold C. Ochsner. *Gastroenterology* 3: 23-29, July 1944.

This is another report on the use of beta(4-hydroxy-3,5-diiodophenyl) alpha phenyl propionic acid (Priodax) for cholecystography. Visualization of the gallbladder was excellent or good in 402 of 600 patients examined (67 per cent); 31, or 7.7 per cent, of these patients exhibited stones. In 81 patients (13.5 per cent) visualization was poor; and 38, or 47 per cent, of this group had demonstrable stones. In 111 patients (18.5 per cent), there was complete failure to visualize the gallbladder shadow; stones were found to be present in 37, or 34 per cent, of this group.

**Aneurysm of the Abdominal Aorta with Rupture into Duodenum. Report of Three Cases.** H. R. Pratt-Thomas. *Am. J. Clin. Path.* 14: 405-412, July 1944.

Forty-one cases of rupture of an aneurysm of the abdominal aorta into the gastro-enteric tract have been recorded; in 32 of these, including the 3 cases reported here, the duodenum was involved. In the first of the author's cases, the clinical impression was peptic ulcer with hemorrhage and saccular aneurysm of the abdominal aorta. The patient died two hours after admission. In the second case, the clinical impression was rupture of an abdominal aortic aneurysm. Carcinoma of the stomach was also seriously considered. Both of these patients gave a history of syphilis. In neither case is any mention made of an x-ray examination. Physical and roentgen examination of the third patient showed a moderately advanced tuberculosis of the right lung with minimal involvement of the left. This patient was observed for about five years, during which there were alternating periods of improvement and exacerbation. A week before death occurred, he suddenly vomited blood and went into moderate shock. Copious black stools followed the hematemesis. No

abdominal masses were palpable. The attending physician thought the patient probably had a peptic ulcer. Tuberculosis was not believed to be a factor. An aneurysm was not considered.

Necropsy in each of the cases showed an aneurysm of the abdominal aorta with rupture into the duodenum.

### THE SKELETAL SYSTEM

**Lumbosacral Roentgenograms of 450 Consecutive Applicants for Heavy Work.** Louis W. Breck, J. Winston Hillsman, and W. Compere Basom. *Ann. Surg.* 120: 88-93, July 1944.

Because of several adverse legal decisions in cases in which pre-employment lumbosacral abnormalities had unquestionably existed, a large industrial concern established the practice of routine roentgen examination of the lower back in all applicants for work involving heavy labor. The present study is based upon the pre-employment roentgenograms of 450 consecutive applicants. In no instance was there a history of backache at the time of examination or previously.

In 86 per cent of those examined some defect was discovered. If the cases of mild wedging of the vertebral bodies and mild lumbosacral narrowing are excluded, this figure is reduced to 31 per cent. In 15 per cent the abnormalities were serious enough to render the applicant unemployable at heavy labor. An additional 8 per cent showed defects that might well lead to future difficulty.

The conditions observed are tabulated and the value of this type of examination is emphasized. [There is one obvious error in the table. The number of patients "with pathology excluding mild lumbosacral narrowing and wedging of thoracolumbar vertebrae should be 141 instead of 249 if the other figures are correct.—Ed.] ELLWOOD W. GODFREY, M.D.

**Lipochondrodystrophia.** Lorenzo Expósito and Argenio de Feria. *Boi. Soc. cubana de pediat.* 15: 1113-1133, December 1943.

The authors present two cases of a rare disease, familial and congenital, characterized by a series of visceral and skeletal dystrophies, in which the presence of lipid substances in almost all organs connected with body metabolism has been demonstrated postmortem. The name of lipochondrodystrophy has been applied to the condition.

The disease was first described by Hunter in 1917. Hurler, by whose name it is sometimes known, recorded 2 cases in 1919. Since then examples have been reported under different names not only in this country but abroad. In all, about 44 cases have been observed. The deposition of the lipid substance in the tissue was first described by Tuthill in one of Hurler's cases.

The term gargoylism has been used to describe the appearance of those afflicted with the condition, because of their striking resemblance to the gargoyle. Patients bear a marked resemblance to one another. The etiology is not clear but some disturbance or congenital defect in the germinal cells is suspected.

A rather minute and extensive description of the post-mortem findings is given. The most important are the abnormal lipid infiltration and the absence of normal cartilaginous growth, which explains the many skeletal changes.

The patients are short, with a large deformed skull,

short trunk and neck, deep nasal fossa, and coarse features. Other clinical evidences of the condition are kyphosis of the dorsolumbar spine, abdominal protrusion, enlarged liver and spleen, corneal opacities, and mental deficiency. The most constant findings are the skeletal changes. Changes referable to the nervous system and ocular opacities are not very constant. Ankylosis and limitation of movement of various joints are often found.

Roentgen studies of the skeleton show no abnormalities in the very young, but these appear and become pronounced as the baby becomes older and are of a chondrodystrophic nature: broadening of the bones of the arm; flattening of the anterior portion of the bodies of the vertebrae, with some backward displacement and lack of depth in the articular cavities; broadening of the ribs anteriorly and laterally with narrowing posteriorly. In some patients coxa vara, metacarpal deformities, and late ossification of the epiphyses occur. The sella turcica may be enlarged, the diaphyses, especially of the wrists, show irregularities.

The diagnosis is easy for those who have ever seen a case, for the general appearance is typical.

A. MAYORAL, M.D.

**Diabetes Mellitus Associated with Albright's Syndrome (Osteitis Fibrosa Disseminata, Areas of Skin Pigmentation, and Endocrine Dysfunction with Precocious Puberty in Females).** Franklin B. Peck and Charles V. Sage. *Am. J. M. Sc.* 208: 35-46, July 1944.

The triad of symptoms described by Albright—osteitis fibrosa disseminata, brownish skin pigmentations, and endocrine dysfunction, with precocious puberty in females—was clearly defined and termed polyostotic fibrous dysplasia by Lichtenstein. The condition may appear in an incomplete form in that all of the signs need not be present.

The disease usually starts insidiously in childhood, and its active phase is terminated when adulthood is reached or when premature epiphyseal fusion occurs. The quiescent phase is reached slowly. The disease is not fatal or hereditary. The diagnosis rests on the clinical aspects, roentgenologic appearance, and absence of abnormalities in the blood calcium and phosphorus. Pathologically, the outstanding features are thinning of the cortex, replacement of marrow and spongiosa by dense, gritty, rubbery fibrous tissue interspersed with poorly calcified bone spicules, and absence of cyst formation. Three roentgenologic features distinguish this disease from hyperparathyroidism. (1) Areas of increased density and overgrowth of bone occur, as well as areas of decreased density. (2) The condition is not generalized, so that normal bone should be found somewhere in the skeleton. (3) The disease practically never involves the epiphyses.

The first case of diabetes in association with polyostotic fibrous dysplasia is reported in a 22-year-old white male who was admitted in severe coma. His head was asymmetric. Brownish pigmented areas were present on the skin of his back. Roentgenograms showed enlargement of the middle and outer tables of the skull, giving the calvarium a mottled appearance suggesting Paget's disease. The mandible was enlarged. Cyst-like areas were present in the pelvis. The femurs showed severe changes, with coxa vara deformities. There were old fractures of some of the ribs and of the neck of the right femur. The left tibia was in-

volved. All laboratory examinations were normal. There was slight exophthalmos, with an elevated basal metabolic rate. The thyroid was palpable.

An insulin tolerance test revealed fairly marked insulin resistance and unresponsiveness to hypoglycemia.

The appearance of severe diabetes, with enlargement of the mandible, exophthalmos, elevated basal metabolic rate and goiter all point to a common factor, the pituitary gland. In another case reported by Sternberg and Joseph there was hyperplasia of the thyroid and thymus, a narrow "lean" adrenal cortex, normal parathyroids, and a basophilic hyperplasia of the pituitary with adenoma formation. The precocious puberty in females having this disease is attributed to a hypothalamic lesion. Albright originally proposed that an embryologic defect in the hypothalamus might result in this disease. BENJAMIN COLEMAN, M.D.

**Cauda Equina Compression Syndrome with Herniated Nucleus Pulposus. A Report of Eight Cases.** J. Douglas French and J. T. Payne. *Ann. Surg.* 120: 73-87, July 1944.

In the authors' experience, complete or nearly complete subarachnoid block with cauda equina compression occurs much more frequently as a result of herniated nucleus pulposus than of tumor. Eight instances of subarachnoid block as manifested by myelography, are reported from a verified series of 90 cases of herniated nucleus pulposus. This represents an incidence of 8.8 per cent. The lesion occurred at the interspace of L-3 in 1 case; L-4 in 4 cases; and L-5 in 3 cases.

Back pain was present in all patients and was the symptom of longest duration. Subsequently, both legs were usually involved. Five patients complained of weakness of the legs, but this symptom was difficult to evaluate because of the pain. Disturbance of sensation in one leg was reported in 4 cases; in the saddle area and both legs in 2 cases; and in the saddle area only in 1 case. Complete retention of urine occurred in 3 cases, and of urine and feces in 1 case. Difficulty in voiding was present in 2 cases, and difficulty in voiding plus constipation in 2 others.

On physical examination atrophy of the glutei, thigh, or calf muscles was found in 4 cases, and weakness and poor muscular tone in the same areas in the remaining 4. Motor impairment was bilateral in 4 patients and unilateral in the remainder. In all instances bilateral sensory disturbances and altered reflexes were present.

Roentgenograms of the back revealed a list in 2 patients. In 5 patients, narrowing of an interspace was demonstrable, but in one of these the narrowing was not at the site of the proved lesion. Hypertrophic changes were present in 2 patients.

In all instances, complete or nearly complete block was demonstrated by myelography. It was felt that this examination was a good indication of the degree of obstruction. In one instance, abnormalities were seen at two interspaces, and at operation an extruded nucleus pulposus was found at L-5 and a protruded intervertebral disk at L-4. There were no untoward reactions to myelography. The myelograms are reproduced.

The operative findings were similar in all cases: extruded nuclei pulposi severely compressing the dural sac were encountered and removed. The dura was opened in 5 cases. No mention was made as to the

condition of the intrathecal contents other than they were "elevated to a marked degree" in 2 cases; in the remaining 3 cases thickening of the arachnoid, matting of the cauda equina, and adhesions were prominently present. In 2 of these cases this was sufficiently marked that obstruction remained after removal of the extruded nucleus pulposus.

All patients were relieved of their pain postoperatively, and were ambulatory and able to void spontaneously on discharge from the hospital.

ELLWOOD W. GODFREY, M.D.

**"Ring" Sequestra As a Complication of Fixed Skeletal Traction.** C. P. Truog. *Am. J. Roentgenol.* 52: 64-69, July 1944.

Skeletal traction in the treatment of fractures is valuable, but there are definite dangers associated with its use. Numerous authors have reported instances of osteomyelitis in cases in which such traction has been employed. The author reports 7 cases of "ring" sequestra, a complication frequently overlooked by the roentgenologist. It is believed that infection starts on the skin and extends along the pin by direct continuity to the bone. Roentgenograms show a hole in the bone made by the introduction of the pin, surrounded by a zone of bone, which in turn is surrounded by a zone of rarefaction. The ring of bone appears slightly more dense than does the surrounding bone. In all the author's cases the "ring" sequestrum developed about a pin through the upper part of the tibia probably because there is more motion of the pin here and more stress upon the bone.

The evidence indicates that "ring" sequestra are probably the result of two factors—pressure necrosis and infection. Their early diagnosis is important in order to prevent further complications. It depends entirely upon roentgen examination.

Five of the author's patients were operated upon and had filling in of new bone at the site of the sequestrectomy, while their draining sinuses healed completely. In 2 cases sequestrectomy was not performed, and draining sinuses persisted at the time of the last observation. The infection is apparently of low grade so that the typical roentgenological appearance of an osteomyelitis does not develop.

CLARENCE E. WEAVER, M.D.

**Knee Injuries in Service Personnel.** John H. Allan and Jesse T. Nicholson. *U. S. Nav. M. Bull.* 43: 63-72, July 1944.

The authors review a series of 153 cases of knee injury exclusive of compound wounds, which received treatment aboard a hospital ship. Ninety-eight patients were hospitalized; 55 were treated as out-patients; 15 were received for convalescence following operative treatment elsewhere, and 44 arthrotomies were done aboard ship.

The authors' statistics indicate that 55 per cent of knee injuries occurred in patients between the ages of twenty and twenty-five years. Thirty-three per cent of those treated surgically had histories of knee injuries prior to entry into the service and 67 per cent had had symptoms for more than one month. A twisting force to the knee was the most frequent source of trouble. The most common injuries encountered were traumatic synovitis, injuries to the internal semilunar cartilage, and sprains of the internal lateral ligaments.



The chief diagnostic problem is to determine whether or not there exists an internal derangement which requires surgical intervention. Roentgen examination was made in all cases in which there was a history of trauma and in all cases in which surgery was indicated. A diagnosis of a cartilage lesion was difficult immediately after the initial injury.

Procaine was efficacious in the treatment of muscular strain but not in ligament strains about the knee. Operation was reserved for cases with evidence of internal derangement. The duration of postoperative convalescence was in proportion to the degree of surgical trauma: the removal of the displaced fragment of a fractured cartilage gave a shorter convalescence than when the entire meniscus was removed. Parapatella incisions prolonged convalescence. Early use of the quadriceps was found to be imperative for a short convalescence. Repeated aspiration for postoperative effusion is recommended. Disability in acute synovitis averaged sixteen days; in sprain of internal lateral ligaments, six weeks; following an arthrotomy, twenty-four days.

The authors recommend that at front-line hospitals with limited surgical facilities elective knee surgery be deferred. Such operations are best done at the locality at which the entire period of convalescence can be controlled.

H. T. GUARE, M.D.

**Injuries to the Ligaments of the Knee Joint.** Leroy C. Abbott, John B. de C. Saunders, Frederic C. Bost, and Carl E. Anderson. *J. Bone & Joint Surg.* 26: 503-521, July 1944.

This is an extensive study of the movements and ligaments of the knee joint. The anatomy is reviewed and the relation of the ligaments to the motions of the knee in various positions is described.

Roentgen examination is of value if a piece of cortex is separated from the bone as a result of pull on a ligament. Also in rupture of the tibial collateral ligament, films will show widening of the joint space on the medial aspect.

JOHN B. McANENY, M.D.

**Traumatic Synostosis of the Distal Third of the Radius and Ulna.** Floyd Hurt and Spencer C. Flo. *Surgery* 15: 894-898, June 1944.

Congenital synostosis of the proximal third of the radius and ulna is not uncommon, more than 200 cases having been reported. Traumatic synostosis of the shaft, however, seems to be a rare abnormality. Only two cases were found in the literature. The case here reported is interesting because the exostosis apparently arose equally from the radius and ulna, forming a pseudarthrosis. There was no apparent narrowing of the interosseous space, and the original fracture, which dated back some years, was in good position. Portions of the exostosis not removed at operation showed gradual absorption rather than regeneration. The etiology is not clear but the condition is believed to have been due to injury of the radius and ulna with a probable subperiosteal hematoma and deposition of bone cells within the clot.

The patient was a 27-year-old soldier who complained of a painful left forearm. He had been struck by a hammer a number of years before and had been told that his arm was broken. A splint had been applied, but no manipulation was attempted and no roentgenograms were taken. There was satisfactory motion

after removal of the splints but a gradual diminution of rotation was noted in successive years with fixation in midpronation for the last two years. On palpation a bony formation could be felt on the flexor surface of the forearm about 6 cm. proximal to the wrist joint. X-ray films revealed a bony bridge at this point, measuring 1.5 X 3.0 cm. joining the radius and ulna. At operation a definite line of cleavage was found in the center of the bridge, corresponding to the pseudarthrosis noted on the film. Following operation the arm could be rotated freely, although x-rays showed a small portion of the bony bridge remaining on the radial side. Two months later this portion of the bridge appeared smaller and all loose fragments of bone were absorbed, except one. This was removed at a second operation.

J. E. WHITELEATHER, M.D.

**Fatigue Fractures.** Percival A. Robin and Samuel B. Thompson. *J. Bone & Joint Surg.* 26: 557-559, July 1944.

Within sixteen months, 15 cases of insufficiency fractures of bones other than metatarsals were encountered. Thirteen involved the tibia, one the femur and one the pubic bone. There were bilateral tibial fractures and one tibial fracture was multiple. The usual history was generalized aching pain over the fracture site following an extended march. In the later stages a palpable mass as a result of callus was present.

The earliest x-ray finding was infraction of the cortex. After one or two weeks new bone formation was seen. The fracture line disappeared in about one month. Treatment consisted in rest followed by walking with crutches until union occurred.

One important finding seems to be the long delay in discovery of the injury, which was on the average 31.4 days. The average hospital stay was 41.3 days. Six patients returned with the same complaint, but no reason could be found for the recurrence of symptoms.

JOHN B. McANENY, M.D.

**Subtalar Dislocation.** L. W. Plewes and K. G. McKelvey. *J. Bone & Joint Surg.* 26: 585-588, July 1944.

It is believed that subtalar dislocation is still sufficiently rare to warrant case reports. Up to the time of this report 155 cases had been recorded. Males predominate in a 6 to 1 ratio and the condition occurs most frequently in the third decade.

An interesting feature is the failure of aseptic necrosis to develop after this severe injury, where seemingly the entire blood supply must be destroyed, though this bone shows an aseptic necrosis after a slight crush injury.

Two case reports are presented, with reproductions of roentgenograms. In one patient great difficulty was encountered in reduction, while in the other case reduction by manipulation was easy.

JOHN B. McANENY, M.D.

**Spinal Extradural Cyst (Diverticulum of the Spinal Arachnoid).** C. Allen Good, Alfred W. Adson, and Kenneth H. Abbott. *Am. J. Roentgenol.* 52: 53-59, July 1944.

A case of spinal extradural cyst seen by the authors is the twenty-first instance of this condition to be recorded. Adelstein's (*J. Bone & Joint Surg.* 23: 93, 1941) review of 17 cases including one of his own is



cited, and references to 3 additional cases are furnished.

The authors' patient, a man of forty-two, experienced weakness and stiffness in the left leg, and a little later in the right. There was sensory loss in the lower extremities. Atrophy in those muscles supplied by the second to the fifth lumbar and the sacral nerves was present on the left. Deep reflexes were hyperactive on both sides. Lumbar puncture disclosed incomplete subarachnoid block. Roentgenograms of the lower thoracic and lumbar regions showed erosion of the pedicles of the eleventh and twelfth thoracic vertebrae. Films made following the introduction of radiopaque oil into the lumbar subarachnoid space demonstrated a complete block opposite the eleventh thoracic interspace. A lateral view showed extradural oil posteriorly and revealed the communication between the cyst and the subdural space. The cyst was removed surgically.

Almost all the reported instances of spinal extradural cyst have been in adolescents. Male patients outnumber female patients four to one. Most of the cysts have been located in the middle or lower thoracic region. Spasticity and weakness are noted at the onset in the lower extremity on the same side as the cyst; later the opposite lower extremity is affected. Pain is usually absent. Manometric tests often show either partial or complete block to the flow of cerebrospinal fluid, and an increase of the total protein content of the spinal fluid may be noted.

Roentgenograms may show changes which are pathognomonic. Enlargements of the spinal canal, together with the changes of kyphosis dorsalis juvenilis in the bodies of the involved vertebrae, are not found in any other condition. If only the history and physical examination are taken into consideration, the condition may be confused with multiple sclerosis or other degenerative processes.

Roentgenograms and drawings are furnished to illustrate the diagnostic signs and the pathological findings in the reported case.

CLARENCE E. WEAVER, M.D.

## GYNECOLOGY AND OBSTETRICS

**Salpingitis and Tubal Patency.** Frederick L. Schwartz. *Am. J. Surg.* 65: 65-73, July 1944.

The relative merits of gas insufflation and hysterosalpingography in determining tubal patency are discussed. The author concludes that hysterosalpingography, when properly done, even in the presence of salpingitis, carries no more risk than any other diagnostic procedure, and while it is subject to more possible complications, the morbidity is negligible. In his opinion hysterosalpingography is superior to insufflation from both the diagnostic and therapeutic standpoint.

One hundred and sixty-five salpingograms were reviewed. All of these films were made as an office procedure and in no instance was there reaction sufficient to prevent the patient coming in for a 24-hour film or from carrying on her regular occupation. All injections were made through a soft-tipped cannula without manometric control. After 3 to 4 c.c. of oil had been injected slowly and gently, a film was exposed, developed, and viewed. Injection was discontinued and a film made, regardless of the amount of oil injected, if the patient complained of severe pain. The series included both sterility studies and examinations of patients with recurrent salpingitis who desired children.

Of this series of 165 patients, 12 became pregnant; in 18 cases a bilateral salpingectomy was done. In all patients subjected to surgery, the findings were confirmed by tissue examination and in all relief of symptoms was obtained. In none of the operated cases was there found any evidence of irritation from the iodized oil.

Salpingitis may be present even though a tube is permeable. Such tubes present certain characteristic radiologic features, such as elongation, clubbing and redundancy at the extremity, and areas of stenosis and dilatation.

In a number of cases, with a record of previous varied treatments, symptoms were relieved by hysterosalpingography.

## THE GENITO-URINARY TRACT

**Perirenal Abscess with Extension into the Right Pleural Cavity Following Rupture of Right Renal Pelvis: Operative Findings and Results.** Neil S. Moore and Harry H. McCarthy. *J. Urol.* 52: 17-22, July 1944.

A case is reported of a right perirenal abscess with extension into the right pleural cavity by transdiaphragmatic fistula. In 1940 the patient had a sudden onset of right flank pain with fever, leukocytosis, and white cells in the urine. Retrograde pyelography showed poor filling of the right renal pelvis, with stones in the inferior calices and in the upper portion of the right ureter. Operation was refused.

Three and one-half years later the patient returned with pain in the right loin and right lower chest, fever, and cough. There were white cells in the urine and the white blood count was 10,000. A dense shadow obliterated the right lower lung field, with some fluid above it. Thoracentesis yielded pus containing a gram-negative bacillus and a few pneumococci. Retrograde pyelography, with methylene blue added to the radiopaque substance, showed a large extrarenal area filled with the dye in the right paravertebral region. Three days later fluid obtained on thoracentesis was tinted blue. Intravenous urography showed a bilaterally functioning urinary tract with extravasation of the dye into the extrarenal area described above.

At operation, a large perirenal abscess was found to communicate with the renal pelvis through a small tear in the latter. The perforation in the pelvis was sutured, the abscess drained, and the sinus tract cauterized. Recovery was uneventful.

A chest film nineteen days after operation showed only slight thickening of the pleura at the right base. It would seem unlikely that a true empyema would resolve so rapidly even under modern chemotherapy.

J. FRANCIS MAHONEY, M.D.

**Actinomycosis of the Kidney; Report of a Primary Case.** Charles P. Mathé. *Urol. & Cutan. Rev.* 48: 313-318, July 1944.

Actinomycosis of the kidney is rare. It occurs predominantly in middle life and in the male. As a rule, the kidney acts as a filter, eliminating the ray fungus from the body, but when renal resistance is lowered by trauma, stone formation, obstruction, infection, etc., colonization of the fungi is favored. Perinephric abscess is a frequent complication.

Renal actinomycosis may be primary or secondary.

The kidney may be involved by direct extension from contiguous structures, as the lungs, intestines, or bladder, or by way of the blood stream. The symptoms are those of any encapsulated infection—fever, loss of weight, anorexia, and weakness—with local tenderness and swelling. The presence of a mass in the loin is not specific for actinomycosis.

In the early stages, pyelography is unreliable. In the presence of advanced disease, it may reveal pressure defects in the calices and pelvis, which are strongly suggestive of neoplastic growth. Positive x-ray signs of cortical and perinephric abscess are usually present, namely renal fixation and obliteration of the psoas muscle shadow, and should suggest the possibility of actinomycosis if tuberculosis and tumor can be excluded.

Sulfur granules may sometimes be present in the urine or in pus from a discharging sinus tract. Isola-

tion of the ray fungus, which requires special anaerobic culture methods, establishes the diagnosis. Nephrectomy is indicated, in two stages if there is a complicating perinephric abscess.

The author reports a case of primary actinomycosis in a calculous kidney, complicated by prostatic abscess and perinephric abscess. It is believed that the organisms were carried to the kidney by the blood stream and that their entrance into the cortex was facilitated by devitalized tissue due to stone formation. Ureterolithotomy, prostatotomy, and drainage of the perinephric abscess were performed. Recovery of the ray fungus from the material drained from the abscess eventually led to the diagnosis, and a two-stage nephrectomy was successfully performed. Once the diagnosis was established, the patient was given large doses of iodides and chiniofon.

MAURICE D. SACHS, M.D.

## RADIOTHERAPY

### NEOPLASMS

**Recent Advances in the Treatment of Carcinoma of the Mouth and Jaws.** T. H. Somervell. *Brit. J. Surg.* 32: 35-43, July 1944.

The author has had the unusual experience of treating 4,853 patients suffering from malignant neoplasms of the mouth, including cheek, lips, tongue, and jaws, during a twenty-year period in a 200-bed mission hospital located in South India. Out of a total of 10,480 operations for malignant neoplasms performed in this hospital during the years 1923-1942, inclusive, 8,439 were done for epithelioma of the mouth. The large number of cases of buccal carcinoma encountered can be explained by the habit of the natives of chewing betel nut mixed with lime and tobacco, especially the strong Vadakkan tobacco of South India and that of Jaffna, Ceylon.

Of the 4,853 cases comprising the series reported, 52 per cent involved the cheek and lips, 28 per cent the lower jaw, 7 per cent the upper jaw, and 13 per cent the tongue. The greater proportion of the cases arise in the cheek. From the cheek the growth, if neglected, spreads in a few weeks to one or both jaws. From the tongue such spread is far more rare, occurring only in a very late stage.

The author is strongly opposed to use of deep x-ray therapy for cancer of the mouth because of the high probability of local recurrence. In addition to this, the ill effects on the general health may reduce the patient to a condition in which he cannot stand further treatment. On the whole, operation is advised for all cases of carcinoma of upper and lower jaws. Radium is considered the best treatment for cancer of tongue or cheek in conjunction with diathermy or operative removal of large fungating growths, cancer of the whole tongue, and epithelioma of the leukoplakic type in tongue or cheek.

In general, growths of the cheek are fairly sensitive to radium, except when they are very superficial and of the leukoplakic type. Radium needles of 1 cm. active length, each containing 1 mg. of radium element, placed 1 cm. apart, may be left in the cheek for ten days. The regional lymph nodes are removed following treatment of the primary lesion in every case, and extraction of

teeth contiguous to the growth is done at the same time, never before radium insertion. The prognosis of radium-treated carcinomata of the cheek is very good, so long as radiation is sufficient, and upon this latter point the author lays special stress. Two or three weeks after treatment, the cheek must be examined; the presence of a superficial ulcer at this time, extending over the whole area occupied by the growth and a little beyond it, means that dosage has been adequate.

For lesions located in the side of the tongue, 4-em. radium needles of 2 mg. strength are used. Most of the needles are inserted at the border of the palpable growth. If the growth is entirely confined to one side of the tongue, a unilateral block dissection of submental, submaxillary, and deep cervical nodes is sufficient. A lesion at the tip of the tongue is best removed by diathermy with irradiation of the base of the wound with short needles inserted transversely. Large soft lesions in the back of the tongue require long needles with high dosage for a short time. When the floor of the mouth is involved, the radium is inserted within the mouth, parallel to the long axis of the tongue, and from without, just inside the edge of the mandible. The cervical nodes are removed later. When the epiglottis and the tonsil region are involved, deep x-ray therapy combined with insertion of long radium needles into the deeper parts of the growth and into the tonsil itself offers a chance of cure.

The author describes his operative methods and makes a plea for closer cooperation between the radiologist and the surgeon. A mortality table is appended showing only 0.2 per cent hospital deaths in cancer of the cheek and lips, 2.0 per cent for cancer of the tongue, 3.4 per cent for cancer of the upper jaw, 8.5 per cent for cancer of the lower jaw. MAX CLIMAN, M.D.

**A Consideration of Dose Distributions in the Treatment of Intrinsic Carcinoma of the Larynx by Radium Implantation.** J. Morton, L. H. Gray, and G. J. Neary. *Brit. J. Radiol.* 17: 204-212, July 1944.

Studies of the dose distribution in the Harmer and Finzi technic of irradiation of laryngeal cancer were made in fixed anatomical specimens by ionization measurements.

The original methods of fenestration showed that the anterior portion of the ventricular fold received 7,250 r, the middle of the fold 5,000 r, and the posterior portion 3,300 r. Points below the ventricular fold were inadequately irradiated. By modifying the technic by removing a narrow strip of the cricoid, a slightly better distribution is obtained, but the dose falls off posteriorly. A better distribution can be had by placing one needle horizontally and by irregular filling of the needles.

The results of the study are shown in diagrams and tables that should be consulted in the original.

SYDNEY J. HAWLEY, M.D.

**Thymic Region Tumors with Acute Leukemia.** N. Puente Duany and A. Castellanos. *Rev. med. cubana* 54: 1062, December 1943; 55: 69 and 152, January and February 1944.

One hundred reported cases of tumors in the region of the thymus with leukemic changes are reviewed, and two new cases are added. These tumors are of two clinical types—one producing symptoms of compression and the other not. In either event the blood picture may show an increase in the number of leukocytes (the hyperleukocytic type), a decrease (the leukopenic type), or a normal count (aleukemic type).

In treating these tumors with x-rays, great care should be exercised, as the thymus is extremely radiosensitive and responds favorably to small doses. Typical leukemia has been known to follow x-ray treatment of tumors of the aleukemic type.

A. MAYORAL, M.D.

**Some Experiences in the Treatment of Bronchial Cancer.** Walter L. Mattick. *Am. J. Roentgenol.* 52: 24-30, July 1944.

From a therapeutic point of view, the most we can expect to achieve in the presence of bronchial carcinoma is to maintain the resistance of the host while we attempt to render innocuous the malignant growth, either by surgical extirpation or radiation sterilization or by both, so as to prevent further dissemination. Therapy, therefore, to achieve beneficial results should be begun early in the course of the disease, before generalized metastasis has taken place.

To date the best results from radiation therapy of bronchial cancer, in the author's experience, seem to have been achieved with 200 kv., with cross-firing to build up a total dose of 12,000 r, with properly directed and angulated portals, distributed over two anterior and two posterior fields. A supplemental course of similar irradiation may be given after one or two months, through previously unirradiated portals, probably three in number, in order to cross-fire into the site of the lesion. In a few selected cases where the intra-bronchial tumor is accessible, gold radon seeds may be implanted through the bronchoscope. In the super-voltage range it would seem from the author's experience so far that good results may be expected especially with 400 kv. With 1,000 kv. the results have not been encouraging.

Four cases are reported, in each of which a histopathologically proved malignant growth in the bronchus has apparently disappeared, as judged by bronchoscopic examination, under radiation therapy, with no recurrence over a period sufficient to make one hopeful that such therapy may and will, if skillfully managed, accomplish lasting results. These cases con-

stitute 3 per cent of a series of 147 treated. The author feels that the results he has obtained are generally more optimistic than many reports on the surgical, radiation, or combined treatment of this condition appearing in the recent literature.

CLARENCE E. WEAVER, M.D.

**Osseous Metastases from Graded Cancers of the Breast, with Particular Reference to Roentgen Treatment.** Hobart A. Burch. *Am. J. Roentgenol.* 52: 1-23, July 1944.

Of all the metastatic malignant lesions in bone, those secondary to cancer of the breast are the most common. On the basis of the evidence in hand, it would seem that metastasis to bone can undoubtedly occur by way of either the blood or lymph channels, although the arguments of von Recklinghausen and his supporters in favor of embolic dissemination through the blood stream appear as yet the more alluring and suggest the latter as the more usual route.

Bone metastases from cancer of the breast are predominantly of the osteoclastic type. Pain is usually the first warning, clinically, of bone involvement. It is of two types: local pain, originating through pressure on the periosteum or on the sensory nerves that supply it, and neuralgic pain, arising from pressure on adjacent nerves. Not rarely the first indication of a metastasis is the occurrence of a pathologic fracture. Pain may precede the roentgen evidence of metastases by several months.

The present study was undertaken principally to determine the bearing which the type of the primary breast cancer might have upon the time of occurrence of bone metastases and their response to roentgen therapy. It is based upon 41 cases with metastases in the spine and pelvis. Broders' system of grading was followed. In no instance in the group of 41 patients used for the study was the primary tumor of Grade 1.

From the observations made on these patients the inference suggests itself that the occurrence of bone metastases from various grades of cancer is roughly proportional to the frequency with which those grades occur in the breast. In general, the lower the grade of malignancy of the primary carcinoma, the longer the duration of life before metastasis to the vertebrae or pelvis occurs. In breast cancer of the same grade, (a) the younger the patient, the earlier the osseous metastases, and (b) the greater the degree of axillary node involvement found at operation, the earlier the appearance of metastatic bone lesions. The location and number of bone lesions apparently bear no relation to the grade of malignancy. They were multiple in approximately two-thirds of the cases of each group. It is impossible to determine the grade of malignancy of the primary lesion on the basis of the roentgen appearance of its osseous metastases.

Relief from pain by roentgen therapy is probably due to retrogression of the metastatic process and destruction of inflammatory tissue at the periphery of the metastatic lesion. In the 41 patients in this study treated for relief of pain, some degree of analgesia was obtained in 35, or 85.3 per cent. Six experienced no relief. In 29, or 70.7 per cent, of the 41 cases the relief was considerable or complete; in 14, or 34.1 per cent, it was complete. Although the higher degrees of relief from roentgen therapy were somewhat more frequent in the Grade 2 and Grade 3 groups than in the Grade 4 group, the likelihood of obtaining some degree

of initial relief was about as great in one group as another. The more favorable response to roentgen therapy, in point of both type and duration of relief, was seen to a greater extent among patients with the lower grades of malignancy. The 35 patients obtaining relief of one type or another came to treatment in an average of three to four and a half months after onset of symptoms; the 6 patients obtaining no relief came for treatment in an average time of 8.5 months after onset of symptoms of bone metastasis. It seems that although relief of any type and any duration can occur in cases of any group, the more favorable responses in point of degree and duration will be seen more often among patients with neoplasms of the lower grades. The history of failures seems to point to the advisability of treating early and treating adequately. It is suggested that in the treatment of the pelvic region multiple beams of high-voltage radiation directed from a minimum of four angles offer the best chance of palliation. The lower the grade of malignancy, the longer the duration of life after the occurrence of bone metastases and after their roentgen treatment. Although palliation was all that was expected, there was undoubtedly prolongation of life in certain individual cases.

CLARENCE E. WEAVER, M.D.

### NON-NEOPLASTIC CONDITIONS

**Local Use of Sulfadiazine Solution, Radon, Tyrothricin, and Penicillin in Otolaryngology.** S. J. Crowe. *Ann. Otol., Rhin. & Laryng.* 53: 227-241, June 1944.

In many members of the Armed Forces in the tropics, as well as those in colder and damper climates, there develops an excessive hyperplasia of lymphoid tissue in the pharynx and nasopharynx, predisposing to frequent colds, chronic nasal congestion, and postnasal discharge. In men subjected to great changes in pressure, as aviators and submarine crews, the ear and sinus lesions may be purely mechanical. In the presence of an acute or chronic infection in the upper air passages, however, these pressure changes often lead to suppuration, necessitating hospitalization and even discharge from service.

Two simple and practical methods of treatment are helpful; (1) local application of a sulfadiazine solution in the nose and nasopharynx to discourage the growth of bacteria and (2) beta and gamma irradiation of the pharynx and nasopharynx to remove hyperplastic tissue. The sulfadiazine gives only temporary relief. The real problem is to get rid of the excess lymphoid tissue. The combination of the two measures is often better than either alone.

Next to the sex cells, lymphocytes are the most radiosensitive cells in the body. Small doses are therefore effective, and danger of burns or of a dry nasopharynx with crust formation is minimal. The action of the radiation is to inhibit mitosis in the germinal centers and thus stop the formation of new lymphocytes.

The author, working in the Johns Hopkins Hospital, uses from 800 to 1,000 millicuries of radon with a brass filter 1 mm. in thickness, but he recommends a more practical technic for use in the Army as well as in civilian hospitals and office practice. This employs an applicator made of monel metal, with a handle 15 cm. long and a chamber 15 mm. long, 1.5 mm. in diameter, and 1.5 mm. in thickness, containing 50 mg. of anhydrous radium sulfate. The results of this technic in 259 children have been as good as with radon, and the

time required for each treatment is only 6.6 minutes. Hearing was improved in a high percentage of cases; a chronic discharge ceased in 15 patients, and 15 with a history of repeated attacks of acute otitis media remained well after irradiation.

A thorough inspection, with a nasopharyngoscope, of the nasal passages, the orifices of the accessory nasal sinuses, and particularly the nasopharynx and orifice of the eustachian tubes, should precede irradiation. The teeth, pharynx, tonsils, and the base of the tongue must be examined. Treatments should be spaced at intervals of four to five weeks. Often only one treatment is necessary, but the nasopharynx should always be re-examined six months later. If any symptoms or visual evidences of recurrence are found, irradiation is repeated. Greatly enlarged adenoids are better treated by operative removal, supplemented by irradiation at the conclusion of the operation.

At the Johns Hopkins Hospital, approximately 125 patients are treated each month in the out-patient department with beta and gamma irradiation of the nasopharynx. It has been the practice to irradiate the nasopharynx only. If the this is freed of lymphoid tissue, recurrent colds become less frequent and severe, and infections in the sinuses, ears, and tonsils often heal spontaneously.

The author outlines protective measures for the operator and discusses also the use of penicillin and tyrothricin for local application. The latter he considers in many ways superior to either penicillin or the sulfonamide powders. STEPHEN N. TAGER, M.D.

**Treatment of Impaired Hearing by Radiation of Excessive Lymphoid Tissue in the Nasopharynx.** Henry D. Rentschler and John W. Settle, Jr. *Pennsylvania M. J.* 47: 985-988, July 1944.

Impaired hearing in children is most often caused by adenoid tissue which blocks the eustachian tubes. The best treatment for this condition is removal of the tonsils and adenoids. If there is a recurrence of excessive lymphoid tissue along the lateral walls and around the eustachian tubes, irradiation should be employed, as lymphoid tissue is the most radiosensitive of all tissues.

The author believes that radium is superior to x-rays in the treatment of this condition because it can be placed in the area where treatment is required and normal tissue does not have to be irradiated. He also finds it difficult to have a child lie still for deep therapy.

The method of Crowe and Baylor is used for radium therapy. The radium or radon is contained in a brass capsule 1 mm. thick and 2 cm. in length, with a handle 13 cm. long. The applicator is passed through the nose and the capsule brought to lie in the region of the fossa of Rosenmüller. A dose of 2 gram-minutes is given to either side and may be repeated at monthly intervals without deleterious effect on the normal tissues.

Where deep roentgen therapy is given, the author uses 200 kv. with a filter of 1 mm. Cu + 1 mm. Al, at 50 cm. distance. Two 6 X 8-cm. lateral facial ports are used, 100 r (measured in air) being given to each portal daily until each has received 400 r. This will give about 260 r to each fossa.

The author has treated 35 patients with excessive lymphoid tissue in the nasopharyngeal region, of whom 19 had impaired hearing and middle ear disease. Those except 4 of this group showed improvement. Those that did not improve were adults with long standing infection.

JOSEPH T. DANZER, M.D.

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# RADIOLOGY

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## Roentgenologic and Pathologic Aspects of Pulmonary Tumors Probably Alveolar in Origin

With Report of Six Cases, One of Them Complicated by Torulosis of the Central Nervous System<sup>1</sup>

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**A**MONG PRIMARY tumors of the chest, pulmonary alveolar-cell tumors are believed to be of relatively rare occurrence. They are characterized by their apparent independence of the bronchial system and by evidence of circumscribed or diffuse intra-alveolar origin and growth. In a recent review of lung tumors, Shinall (5) mentions that, during a five-year period, he did not see a single definite instance of carcinoma arising from the pulmonary alveoli. While the comparative scarcity of this type of tumor is not questioned, its infrequent observation may be due, at least in part, to the intrinsic difficulties of premortem radiologic and clinical diagnosis. The purpose of this report is to present six probable cases of alveolar-cell tumor and to discuss their differentiation from bronchiogenic and metastatic lung tumors and from infections with a similar x-ray appearance.

**CASE 1:** G. D., a 49-year-old baker, was first seen on May 10, 1940, complaining of cough, pain in the chest, and loss of weight for the past five months. Previous and family histories were not significant. The physical examination showed the patient to be cyanotic, dyspneic, and emaciated. Resonance was impaired over the bases of both lungs, especially on the left, where the breath sounds were diminished. The roentgenogram showed a large pleural effusion

on the left and small scattered radiopacities in the right lung, suggestive of metastatic tumor invasion. (Due to the death of the roentgenologist, the roentgenograms are no longer available.) Bronchoscopy failed to show any obstruction. The symptoms increased in severity and, according to the roentgenologic report, pathologic changes became more visible in the left chest. Death occurred Sept. 5, 1940.

**Autopsy:** The left pleural cavity contained 800 c.c., the right 100 c.c., of yellow fluid. Both lungs were studded with firm gray nodules, measuring about 0.3 cm. in diameter and occasionally coalescing. Bronchi and bronchioles were free from tumor. Liver and adrenals showed nodules similar to those in the lungs.

**Microscopic Examination:** The nodules were composed of anaplastic columnar cells that lined fairly well preserved alveolar walls. The cells often formed papillary projections; some cells contained dust particles or pigment. Mitosis was infrequent. Occasional bronchi revealed nests of tumor cells in the submucosa. Thrombosis, inflammation, and early abscess formation were seen in one section. Metastases, mostly in a glandular pattern, were found in the hilar lymph nodes, liver, and adrenals.

**CASE 2:** L. C., a 53-year-old woman, entered the hospital on June 24, 1943, complaining of blurred vision, difficulty in articulation, drowsiness, and loss of weight. Her mother had died at sixty-five of a brain tumor. The past personal history was non-contributory.

The patient was emaciated, with lungs normal to percussion and auscultation. She showed frequent causeless laughter and giggling, a positive Romberg sign, mild ataxia in gait, bilateral nys-

<sup>1</sup> From the University of Colorado School of Medicine and Hospitals, Denver, Col. Accepted for publication in July 1944.



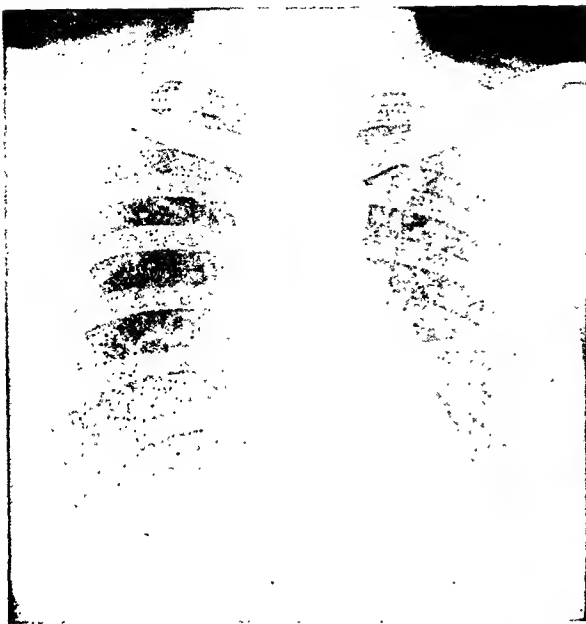


Fig. 1. Case 2. Multiple small areas of increased density throughout the upper three-fourths of both lung fields.

tagmus, and slight stiffness of the neck. The spinal fluid findings were as follows: cells 181, globulin trace, protein 130 mg., sugar 41.5 mg. per 100 c.c. In the cisternal fluid, budding, doubly refractive yeast-like cells were found. *Cryptococci hominis* (Torula organisms) were isolated from an inoculated mouse and a guinea-pig.

Roentgen examination of the chest (reported by Dr. J. H. Jamison, Denver) disclosed multiple small areas of increased density distributed throughout the upper three-fourths of both lung fields (Fig. 1). These areas did not have the characteristics of pulmonary tuberculosis but corresponded more closely to the findings in a fungous infection such as moniliasis, aspergillosis, or blastomycosis. The cardiac silhouette was within normal limits as to size and shape, and there was no irregularity of either hemidiaphragm.

Diagnosis of torulosis was made and the patient was treated with sulfadiazine. The clinical course was slowly retrogressive; signs of meningitis became more pronounced. Iodides and acriflavin hydrochloride were administered. Torula organisms were found in six out of eight specimens of spinal fluid. Death occurred on Sept. 22, 1943, three months after admission.

**Autopsy:** The left pleural cavity contained 300 c.c. of straw-colored fluid; the right was dry. In both lungs were numerous firm, gray, round tumor foci, measuring 0.5 to 1.0 cm. in diameter and occasionally encroaching upon the pleura. Bronchi and mediastinal lymph nodes were not affected. The leptomeninges showed scattered areas of thickening without definite exudate. Globular tumor foci, similar to those in the lungs, were scattered through the brain; some showed central softening.

**Microscopic Examination (Fig. 2):** In the tumor foci, the alveolar walls were thickened and lined by cuboidal, epithelial-like neoplastic cells. Mitoses, giant cells, fragmented nuclei, papillary projections, and desquamation of tumor cells into the alveolar lumina were observed. Some alveoli contained polymorphonuclears and macrophages. Occasional lymphatics contained tumor cells. Bronchi and lymph nodes were not affected. The neoplastic foci in the brain displayed a papillary-glandular pattern

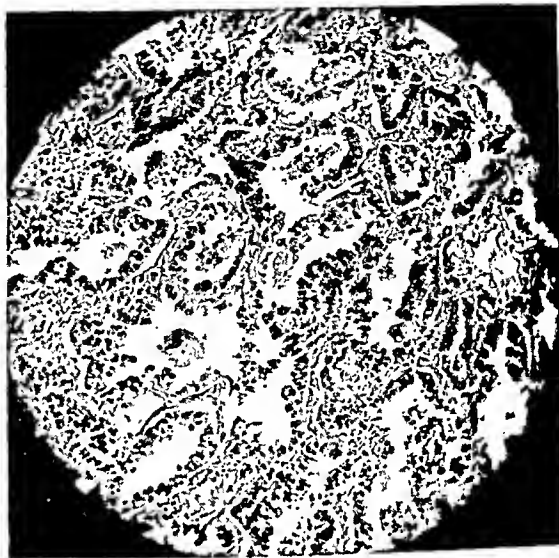


Fig. 2. Case 2. Photomicrograph showing preservation of alveolar framework; alveoli lined and filled with epithelial-like cells.  $\times 45$ .

and, in many places, showed central necrosis. The thickened areas in the meninges also were composed of neoplastic cells. No *Cryptococci* could be demonstrated and torula meningitis was not apparent.

**CASE 3:** E. R., a 17-year-old school girl, had a hacking productive cough, accompanied by loss of weight and strength, in July 1942. In December, she suffered from pneumonia for three weeks. Symptoms continued, and sputum was occasionally blood-streaked. A pleurisy with effusion developed in March 1943. Physical examination, on July 1, 1943, revealed a tall, thin girl with a loose, rattling cough. The chest was retracted on the left, with dullness, coarse moist râles, and bronchial breath sounds. There were also scattered râles in the central field on the right.

Roentgen examination (by Dr. Van Atta, Albuquerque, N. M.) showed extensive nodular infiltrative changes (Fig. 3), partly confluent, in the right middle and lower thirds (costophrenic angle excepted). A slight tenting of the right diaphragm indicated pleural adhesions. The left hemithorax was almost homogeneously dense. Though the cardiac outline could not be definitely ascertained, the heart and the trachea seemed to be markedly displaced to the left. Judged by the position of the

*Magenblase*, the left diaphragm appeared elevated. These criteria rather pointed to extensive atelectatic and fibrotic changes or tumor formation than to pleural effusion, but complication by pleural fluid was considered plausible roentgenologically.

The sputum (smears and culture) was persistently negative for tubercle bacilli or fungi. A diagnosis of pulmonary cancer was made. The course was rapidly retrogressive, with increasing dyspnea. Death occurred Aug. 29, 1943.



Fig. 3. Case 3. Extensive nodular infiltration in right middle and lower thirds. Almost complete radiopacity over left hemithorax with elevation of left diaphragm and displacement of heart and trachea to the left.

*Autopsy:* The left pleural cavity was obliterated. The left lung and right middle and lower lobes were occupied by grayish, firm, nodular tumor, with sclerosis of the intervening tissue. Nodules varied from the size of a pinhead to 1.0 cm. in diameter. The bronchi showed no involvement. There were no metastases.

*Microscopic Examination:* Alveolar walls were partially or completely lined by columnar cells with eosinophilic, granular, or vacuolated cytoplasm and oval or irregular nuclei. Mitosis was rare. Pseudostratification, papillary protrusions, and mucinous secretion were not infrequent. Some fields showed necrosis and infiltration with macrophages and leukocytes. There was marked fibrosis of the intervening lung tissue. Bronchioles and lymph nodes were free from tumor.

CASE 4:<sup>2</sup> F. M., a 76-year-old man, was ad-

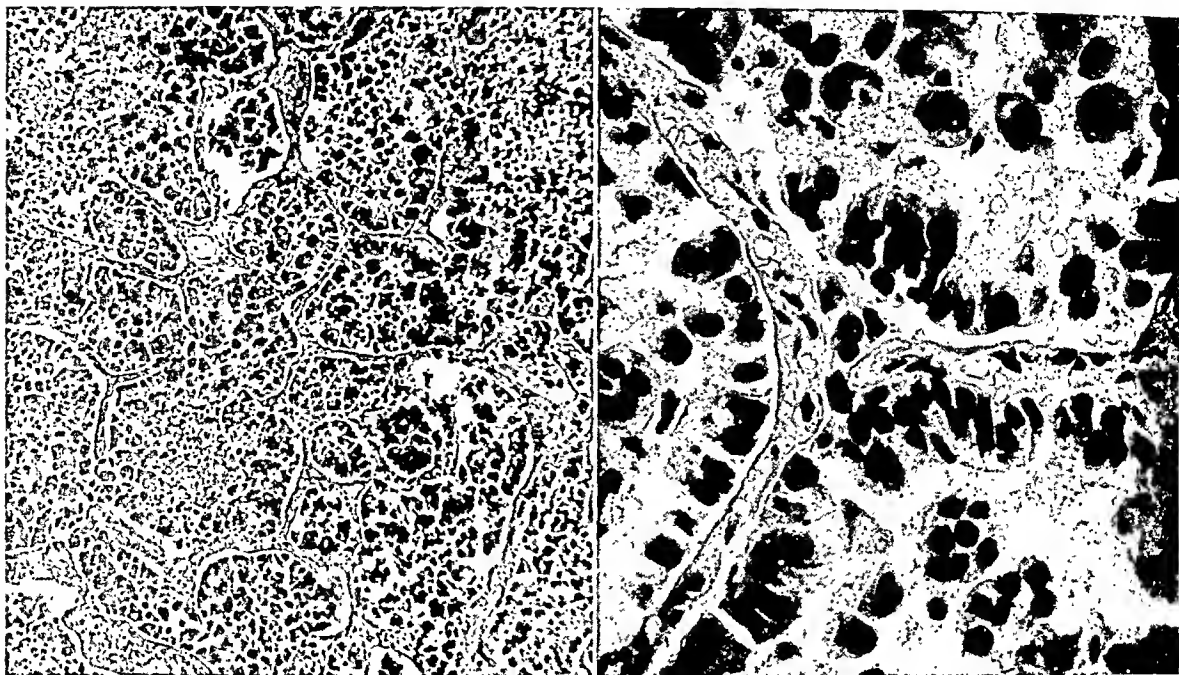


Fig. 4. Case 4. Extensive infiltrative-consolidative changes in left middle and lower thirds. Prominence of bronchial markings in right infraclavicular region and lower third. Some "honeycombing" in some areas. Slight displacement of heart to the left. Small amount of pleural effusion, left.

mitted on Jan. 16, 1941, complaining of progressive shortness of breath for one year, and of increasing dyspnea, cough, and swelling of the feet during recent days. Neither the past nor the family history was remarkable. Physical examination revealed extreme dyspnea, orthopnea, and cyanosis; the chest was barrel-shaped; moist râles were heard in the base of each lung, combined with bilateral bronchial breathing.

X-ray examination of the chest (Colorado General Hospital, Jan. 16, 1941) revealed extensive infiltrative-consolidative changes in the left middle and lower thirds (Fig. 4) and marked fibrosis in the right infraclavicular region and lower lobe. There was a suspicion of "honeycombing" in the right lower lobe and in the more translucent areas of the left chest. The outlines of the left heart border and the left diaphragm could not be definitely ascertained, but to judge from the position of the right cardiac border, there seemed to be some displacement of the heart to the left. Homogeneous density in the left costophrenic angle and lateral lower third suggested pleural effusion. The differential x-ray diagnosis rested between (1) pneumonitis with bronchiectasis (diagnosis of choice), (2) widespread chronic tuberculosis with fibrosis and bronchiectasis, (3) tumor invasion of the left hilus and lower lobe with inflammatory complications and bronchiectasis. (X-ray check examination was advised for a more definite diagnosis, but the patient grew rapidly worse and died before further studies could be attempted.)

<sup>2</sup> This case was included in the review on "The Morphology of Primary Carcinoma of the Human Lung" by R. M. Mulligan and F. R. Harper, *J. Thoracic Surg.* 12: 734-752, 1943.



Figs. 5 and 6. Case 4. Photomicrographs showing preservation of alveolar framework; alveoli lined and filled with neoplastic cells.  $\times 45$  and  $\times 400$ .

The sputum was positive for type III pneumococci, and a diagnosis of pneumonia was made. The patient was placed in an oxygen tent and given antipneumococcus serum and glucose solution intravenously. The course, however, was steadily downhill, and death occurred Jan. 25, 1941.

**Autopsy:** Scattered adhesions in the left pleural cavity were present. The right lung (630 gm.) was congested and subcrepitant in its posterior portion. The left lung (1,210 gm.) showed a mixed grayish yellow and white firm tumor (measuring  $10 \times 10 \times 14$  cm.), occupying the anterolateral portion of the upper lobe, with some satellite nodules in the vicinity. The lower lobe was congested and free from tumor. Metastases were found in regional and peripancreatic lymph nodes, pancreas, adrenals, and kidneys.

**Microscopic Examination** (Figs. 5 and 6): In the left upper lobe highly anaplastic cells filled and, in many fields, clearly lined the alveoli. Many mitoses were noted. There were masses of tumor cells in vessels and lymphatics. In some fields, alveolar walls were broken down, but generally they were intact. Scattered areas of necrosis occurred. Bronchi and bronchioles revealed no point of origin for the neoplasm. Metastases exhibited anaplastic cells with an atypical glandular pattern.

**CASE 5:** H. W., a 58-year-old tailor, was admitted to the hospital on April 8, 1944, with a cough of one year's duration, progressive weakness, and considerable loss of weight. He had been in the National Jewish Hospital where a diagnosis of lung tumor was made and immediate surgery was advised. Three weeks before admission, a severe coughing attack

occurred, with dyspnea and cyanosis. The patient was placed in an oxygen tent. There was no record of any previous disease, except influenza in 1918. The family history was negative. On admission the patient was in great distress, with dyspnea and cyanosis. The chest examination was difficult, due to continuous coughing. The respiratory excursions were more pronounced on the left. Coarse moist râles were audible everywhere. There was dullness to percussion along both sides of the spine, particularly on the left. The breath sounds decreased over the right field posteriorly.

X-ray examination of the chest (National Jewish Hospital, Denver, Feb. 24, 1944) showed a large oval area of infiltration and consolidation over the left hilus as well as extensive peribronchial infiltrative changes radiating from the left hilus throughout the left lung, most pronounced in the first and second costal interspaces (Fig. 7). The left lung appeared generally less radiotranslucent than the corresponding right. The measurements of the heart reached the upper limits of the normal. The left diaphragm was slightly elevated. The position of the heart and the appearance of the costophrenic angles were normal. The radiological diagnosis was primary malignant tumor invasion of the chest, apparently originating in the region of the left hilus. Exclusion of acute infection by history and clinical examination was suggested.

The patient remained extremely dyspneic, became comatose, and died on the third day after admission.

**Autopsy:** The lower third of the right pleural cavity was obliterated. The left pleural cavity showed



Fig. 7. Case 5. Large oval area of infiltration over upper portion of left hilus. Extensive peribronchial infiltration radiating from left hilus throughout left lung (most prominent in first and second costal interspaces).

studding of the visceral and parietal pleura with small, firm, rounded nodules; 300 c.c. of fluid were present on the right and 1,500 c.c. on the left. The weight of the lungs was 675 gm. (right) and 945 gm. (left). The left upper lobe was firm and non-crepitant, with a contracted area with deep fissuring of the surface on the lateral aspect. A cut section exhibited an almost solid mass of compact, pale gray neoplastic infiltration (Fig. 8). The lower lobe showed a few small tumor nodules. The right lung displayed a firm, uniform, reddish-gray consolidation in the middle lobe, and a few small abscesses in connection with dilated bronchi in the lower lobe. The bronchi were otherwise normal. There were no metastases, with the exception of implants on the pleura and pericardium.

*Microscopic Examination* (Fig. 9): The left upper lobe showed the alveolar structure preserved in most fields. The alveolar walls as well as those of some alveolar ducts were thickened and lined by cuboidal or cylindrical cells, with occasional mitoses and giant cells. Papillary protrusions and cellular desquamation, sometimes with solid plugs of tumor cells, were observed. Mucoid material, dust cells, and foamy phagocytes were present in some of the neoplastic alveoli. The new growth was broken up in several places by coarse strands of connective tissue. In some fields, the alveolar pattern was less distinct, and the appearance resembled bronchiogenic adenocarcinoma. Bronchi and bronchioles, however, were free from tumor. Many lymphatics contained tumor cells. Pleural foci exhibited neoplastic tissue in a glandular pattern or in small solid



Fig. 8. Case 5. Diffuse neoplastic infiltration of upper lobe; scattered nodules in lower lobe. Note absence of bronchial involvement.

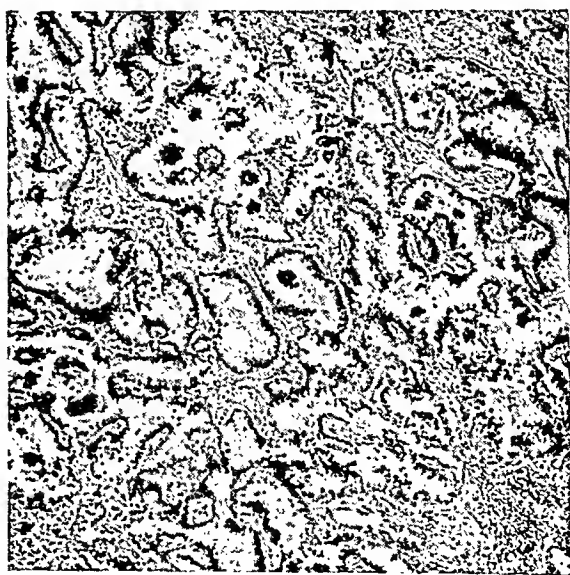


Fig. 9. Case 5. Photomicrograph showing neoplastic alveolar lining similar to that seen in other cases; thickening of alveolar walls; interstitial sclerosis.  $\times 35$ .

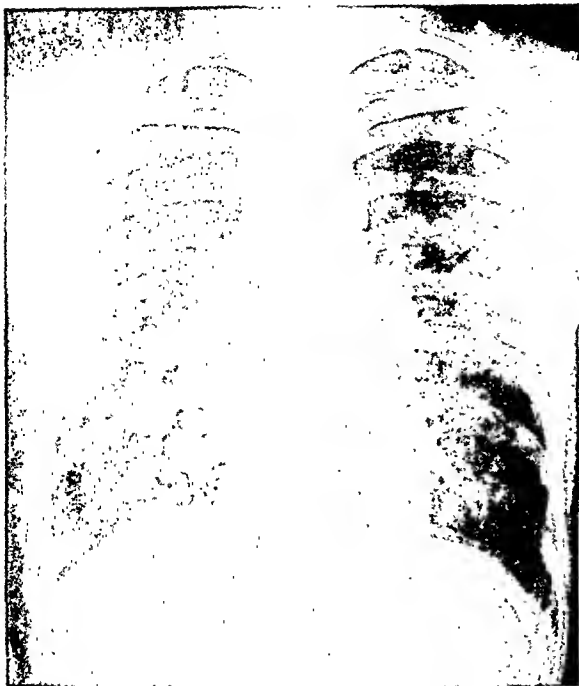


Fig. 10. Case 6. Multiple rounded and oval areas of radiopacity (apparently tumor invasion) throughout both lungs.

necks. The right middle lobe showed widespread organizing pneumonia and a large number of alveoli filled with macrophages.

**CASE 6:** This case was described from a pathological point of view by one of us (N.) in the *Journal of Thoracic Surgery* (4). Since, however, no roentgenograms of the case were ever published, nor was it ever discussed roentgenologically, a brief résumé with roentgen findings appears to be indicated in this connection.

M. Q., a 39-year-old WPA worker of Mexican descent, who had been a miner from 1918 to 1936, was admitted to the Colorado General Hospital on Nov. 17, 1938. His chief complaints were loss of weight, severe and persistent cough, weakness, and postprandial epigastric distress. The breath sounds were somewhat harsh over both apices. Examinations of the gastro-intestinal and genito-urinary tracts by clinical, laboratory, and x-ray methods were essentially negative.

X-ray studies of the chest, on Nov. 22, 1938 (Fig. 10), showed both lung fields studded with multiple round or oval areas of increased density ranging from the size of a millet seed to that of a cherry, partly confluent and especially prominent in the hili and middle thirds. The heart was of normal size and position. The left costophrenic angle was slightly obtuse. The right costophrenic angle and the diaphragm were normal.

The x-ray appearance primarily suggested far-advanced pulmonary metastases but, considering the patient's history and apical involvement, complications by additional factors (silicosis, fungous

disease, or tuberculosis) could not be definitely ruled out.

Further x-ray and clinical examinations (gastro-intestinal and genito-urinary tracts, bones, etc.) failed to reveal any evidence of primary tumor.

More for diagnostic than therapeutic purposes, x-ray deep therapy was administered to the chest in two different series: 2,900 r to the left chest (from Dec. 5 to Dec. 13, 1938) and 1,600 r to the right chest (from Jan. 7 to Jan. 11, 1939).

X-ray examination (Dec. 27, 1938) following deep therapy of the left chest showed some decrease in the extent of the tumor involvement of the left lung. This improvement was only temporary, however, and the second treatment series had to be discontinued on account of untoward symptoms (slight fever, increasing weakness, and vomiting). The patient was discharged to a convalescent home but left for his own home where he died a few weeks later (Feb. 7, 1939).

The anatomical-pathologic diagnosis was: (1) primary multiple alveolar-cell tumor of both lungs; (2) chronic pneumonia in the remaining lung tissue; (3) slight pleural adhesions in the right lung; (4) tumor metastases in mediastinal and periaortic lymph nodes, liver, and kidneys; (5) emaciation.

Figure 11 shows a gross section of the lung. The microscopic findings as well as the pathologic reasoning leading to this unusual diagnosis are discussed in detail in the article cited above.

## DISCUSSION

Case 1 seems typical of the multiple nodular type of alveolar-cell tumor. The symptoms were similar to those of bronchiogenic carcinoma, *i.e.*, cough, pain in the chest, loss of weight, weakness, and dyspnea. Bronchoscopy, however, was negative, and necropsy failed to reveal a bronchiogenic origin of the tumor.

Case 2, also, is fairly typical of the multiple nodular type. The symptoms, however, were predominantly due to cerebral and meningeal metastases; there was little clinical evidence of a primary pulmonary tumor. It is believed that this is the first report of clinical torulosis associated with alveolar-cell tumor of the lung. Why the torulosis failed to produce the usual histologic lesions in the brain is undetermined. That the reported presence of *Torula histolytica* was due to clinical or laboratory error seems remote, as the examinations of the spinal fluid were repeated some eight times, and specimens were examined independently by the lab-



oratory of the Presbyterian Hospital and the Department of Bacteriology of the University of Colorado. Both laboratories agreed on the identification of the yeast. Possibly the answer lies in the existence of a *Cryptococcus* that is pathogenic for white mice but is not productive of pathologic lesions in man.

Case 3, again a nodular type, found in a girl of only seventeen, failed to show me-

Case 6 is a very good instance of the nodular form, leading to widespread metastases.

In a review of this subject in 1942, two of us (Neubuerger and Geever, 3) were able to collect 24 clear-cut cases of alveolar-cell tumor from the world literature. Since the appearance of that review, Dacie and Hoyle (2) and Wood (8) have reported 2 additional cases. Some authors

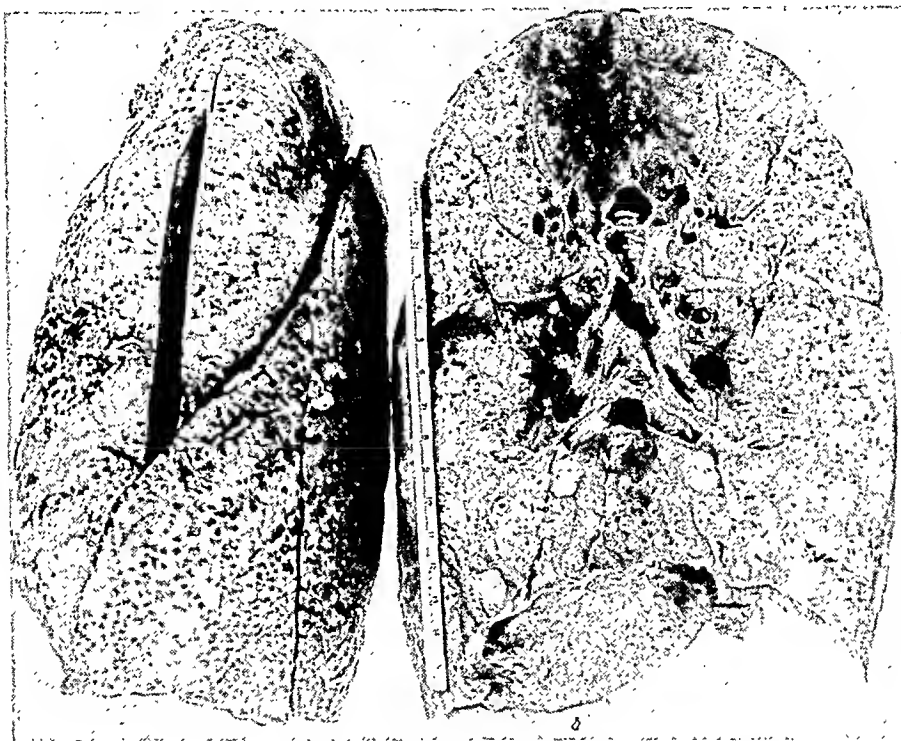


Fig. 11. Case 6. Alveolar-cell tumor with multiple discrete foci.

tastases and revealed somewhat less cellular anaplasia than the first two cases.

Case 4 is fairly characteristic of the diffuse form. The diagnosis was obscured by an associated bronchopneumonia with type III pneumococci in the sputum. The neoplasm was highly malignant and produced widespread metastases.

Case 5 is probably another good example of the predominantly diffuse form. Distant metastases were absent. Although the structure of the tumor in some areas was suggestive of bronchiogenic adenocarcinoma, no starting point in the bronchial system was found.

designated these tumors as alveolar carcinoma in the belief that they had their origin in alveolar epithelium. This, however, introduced a controversial histologic subject, as anatomists do not agree on the presence or histogenetic character of the alveolar lining cells. And for this reason we expressed preference for the term "alveolar-cell tumor." Microscopic examination in all cases here presented favored the belief that the origin of the neoplastic growth was in the alveolar walls.

A completely satisfactory proof of this opinion cannot, of course, be offered. Opponents of the existence of the alveolar-

cell tumor will maintain the conviction that the neoplasms under discussion arise from some single focus, probably in a smaller bronchus, and then metastasize rapidly to other parts of the lungs, by way of down-growth in the bronchial tree and by extension through the pores of Kohn, the lymphatics, and blood vessels. Only serial sections through the lungs would enable one to make an irrefutable statement as to lack of primary bronchial involvement in a given case. We have discussed these controversial points in the above-cited review. In spite of the unavoidable inadequacies in the argumentation, the cases here reported offer so many differences from other forms of pulmonary tumors that they should be given special consideration.

Although the majority of alveolar-cell tumors have been definitely malignant, some were borderline or histologically benign. The older cases were reviewed in our earlier paper. More recently, Sims (6) has reported a benign tumor of this class in a 42-year-old man and designated it as "bilateral multiple pulmonary adenomatosis." Bell (1) described a similar case and called it "extensive diffuse epithelialization of the alveoli" rather than true neoplasm. Taft and Nickerson (7) saw two similar examples, with marked mucous secretion ("pulmonary mucous epithelial hyperplasia"). Our third case was somewhat similar: the histologic grade of malignancy was slightly lower than in the other instances, mucinous secretion was marked, and regional and distant metastases were absent.

In an analysis of all reported cases, it was found that the clinical features of this tumor are similar to those of other lung tumors, *i.e.*, cough, pain in the chest, pleural effusion, cyanosis, and bloody sputum. In some instances the prevailing symptoms were due to intracranial metastases, as in our own Case 2. Even in the cases with histologically "benign" tumors, the final outcome is often fatal as a result of involvement of large areas of the lung or secondary infections processes. The prognosis, then, is unfavorable in the over-

whelming majority of cases. Unilateral or monolobar tumors of the diffuse type occasionally may be amenable to surgical or x-ray treatment.

From a roentgenologic point of view, the protean appearance of alveolar-cell tumor explains the difficulty of conclusive diagnosis. As demonstrated by our cases, the roentgen appearance may simulate bronchiogenic carcinoma (Case 5) or a metastatic tumor (Cases 1 and 6), or it may have the appearance of fungous or tuberculous infection (Case 2) or of pneumonitis (Cases 3 and 4). As a further confusing factor, complications, especially pleural effusion, bronchiectasis, and cavitation, may enter into the picture, as occurred in Cases 3 and 4. These complications may be the direct result of the tumor, through pressure (atelectasis), invasion of the pleura (effusion), or tissue destruction (cavities), or they may be entirely incidental and have no connection at all with the neoplasm, as, for instance, the torula infection in Case 2 and the pneumococcus pneumonia in Case 4. In 3 of the 6 cases, a pulmonary neoplasm was definitely diagnosed roentgenologically, premortem, though the true character of the alveolar-cell tumor could not be gauged in the roentgenogram: because of the multiple bilateral rounded foci, Cases 1 and 6 were diagnosed as pulmonary metastases, while Case 5 seemed to have all the earmarks of a bronchiogenic carcinoma. In 2 other cases (3 and 4), tumor invasion was more or less seriously considered, but the general picture was too obscured by inflammatory changes and complications to make that the diagnosis of choice.

It is worth while to note that some of the older cases were misdiagnosed as tuberculosis or pneumonia, even following gross necropsy study. Clinical factors may tip the scales in favor of tumor diagnosis, as lack of fever, loss of weight, progressive weakness, a chronic course, etc., but it must be assumed that, at the present stage of our knowledge, as far as alveolar-cell tumor of the lungs is concerned, particularly its diffuse type, the definite



diagnosis in the majority of cases lies beyond the realm of roentgenologic differentiation and can be made only by microscopic examination. However, in all patients with multiple nodular, seemingly metastatic shadows, without evidence of a primary tumor elsewhere, this neoplasm should be considered.

#### SUMMARY

1. Six cases of apparent pulmonary alveolar-cell tumor are presented. In one patient the diagnosis was obscured by a complicating torulosis.

2. The roentgenologic, pathologic, and clinical aspects of this type of tumor are discussed. The difficulty of roentgenologic and clinical diagnosis is stressed.

3. Although not nearly so common as bronchiogenic neoplasms, tumors may arise in the pulmonary alveoli and produce fairly distinctive pathologic changes.

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# The Roentgen Features of Eosinophilic Infiltrations in the Lungs<sup>1</sup>

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THE CONDITION to be described has been previously reported under various designations, including eosinophilic pneumonia, Löffler's pneumonia, Löffler's syndrome, and transient pulmonary infiltrates with eosinophilia. Between 1931 and 1936, Löffler reported 51 cases in which transient pulmonary exudates were found associated with eosinophilia. He considered the condition a well defined clinical entity, characterized roentgenographically by the sudden appearance of pulmonary infiltrates of variable size, density, and distribution (1). He classified these shadows in four groups: (1) extensive areas of massive density simulating tuberculous consolidation; (2) smaller round single foci like those of the early tuberculous infiltrate; (3) multiple small infiltrates in one or both lungs; (4) infiltrates of lobar extent simulating abortive pneumonia. The main characteristic of these infiltrates was their sudden appearance, with complete disappearance within three to eight days.

The other characteristic feature of the condition was the accompanying eosinophilia with counts ranging up to 66 per cent, but averaging 10 to 30 per cent. There appeared to be no correspondence between the degree of eosinophilia and the extent of the pulmonary involvement. The benign character of the associated symptoms was another clinical feature. There was little or no fever, and slight disturbance in the general condition of the patients. The meagerness of abnormal physical findings in the lungs and of pulmonary symptoms was also noteworthy.

All of Löffler's cases were of the benign variety and of very brief duration. Other authors (2, 3, 4, 5) have described more

chronic forms of the disease, frequently associated with more severe symptoms. In these the pulmonary infiltrations remained demonstrable roentgenologically for many weeks or months.

The present report is concerned largely with the roentgen features of the disease. Most of the cases have already been described from the clinical and pathogenetic points of view by Harkavy (4, 5).

## CASE REPORTS

The first three cases are examples of the relatively benign group, and the last two illustrate the more complicated and malignant forms of the disease.

CASE 1 (Fig. 1): F. B., a young woman, first came under observation in February 1934 at the age of 21, fifteen months after the onset of an acute illness characterized by high fever for ten days, followed by cough, weakness, and loss of weight, requiring a convalescent period of two months. At that time, because some cough and weakness persisted, an x-ray examination of the chest was made, which disclosed extensive bilateral exudative lesions. A diagnosis of pulmonary tuberculosis was made, and the patient was sent to a sanatorium, where she remained for five months. During this time the pulmonary infiltrates cleared, casting serious doubt upon the admission diagnosis of tuberculosis. After a period of apparently normal health and activity, mild constitutional symptoms with low-grade fever and cough recurred. At the same time the pulmonary infiltrates reappeared. The patient was referred to the Mount Sinai Hospital for investigation, with a diagnosis of pulmonary infection of unknown cause. By the time she was admitted the infiltrates had cleared completely. The significant findings during her short stay in the hospital were a few transient wheezing râles at both bases and an eosinophilia of 17 per cent.

During the subsequent years the patient had many recurrences of the pulmonary infiltrates with complete clearing in from a few to many weeks. Altogether she had ten recurrences from 1932 to 1939; there has been none since 1939.

<sup>1</sup> From the Chest Group and the Department of Radiology of the Mount Sinai Hospital, New York, N. Y. Accepted for publication in April 1944.

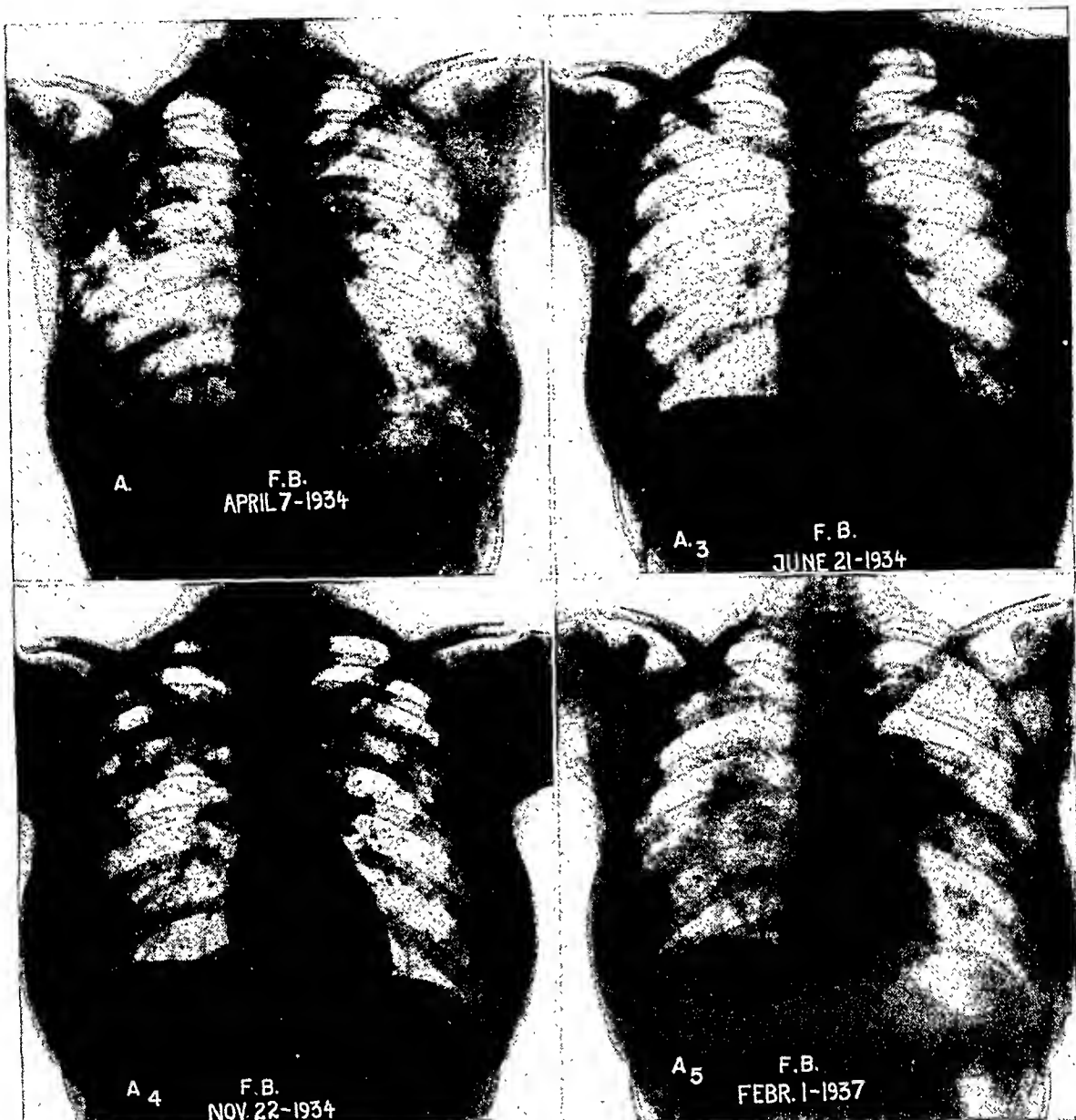


Fig. 1. Case 1. On April 7, 1934, there were nodular infiltrations throughout both lungs, particularly in the upper lobes. Some of the nodules were confluent, simulating exudative areas, as in tuberculosis. By June 21, 1934, the lungs had returned to normal. Recurrences in November 1934 and February 1937 showed patchy exudative lesions. More characteristic, however, are the irregular oblique, plate-like densities, the precise location of which has not been determined.

The other pertinent clinical features were as follows. There was a strong familial history of allergy. The patient herself had a history of recurrent sinus infection with roentgen evidence of disease in the antra and sphenoid sinuses and eosinophilia varying from 17 to 54 per cent during "attacks." Eosinophils were also present in the sputum. Positive cutaneous reactions were elicited to foods, pollens, and to bacterial products obtained from sinus washings. In 1937, for the first time, the patient exhibited typical attacks of bronchial asthma. She was

treated (Dr. Harkavy) with vaccine and pollen extracts and has been entirely well since 1939.

CASE 2 (Fig. 2): E. E., a woman of 28, first came under observation in May 1942, with a history of recurring attacks of bronchial asthma of moderate severity for ten years. During the ten weeks prior to her admission to the Mount Sinai Hospital, she had two or three severe asthmatic paroxysms daily, associated with fever up to  $101^{\circ}$  F. and a cough productive of abundant mucopurulent sputum. Because of the roentgen appearance of the lungs, pul-



Fig. 2. Case 2. Exudative lesion in the right upper lobe. There is no evidence of contraction of the lobe. Indefinite nodular infiltrations in the left upper lobe. Six months later, the lesion had largely disappeared.

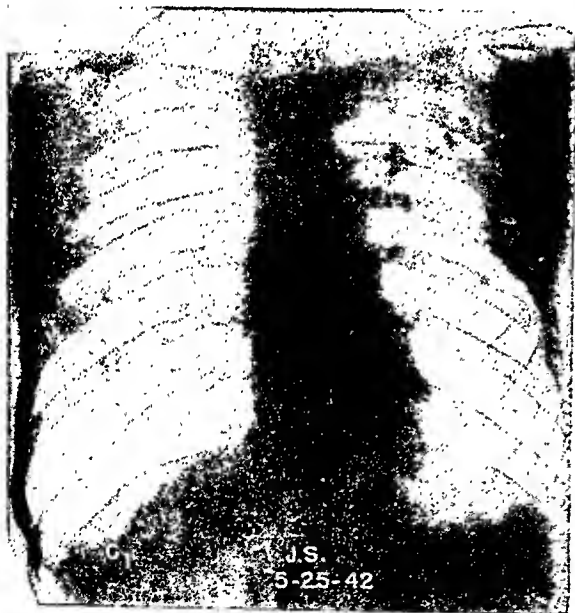


Fig. 3. Case 3. Exudative lesion in the left upper lobe with a characteristic irregular oblique density in the lateral third of the chest. There are indefinite nodular infiltrations in the left upper lobe.

monary tuberculosis was diagnosed. However, 12 sputum examinations by the concentration method failed to show the presence of tubercle bacilli. Flood examination revealed an eosinophilia of 42 per cent.

The infiltrates in the lungs largely resolved during the ensuing months. Complete investigation of the

case disclosed chronic sinus disease and marked sensitivity to pollens, foods, and bacterial products from the material obtained from the sinus washings. Treatment has resulted in improvement in the asthma. There has been no recurrence of the pulmonary infiltrates to date.

CASE 3 (Fig. 3): The patient was a man of 27 years, who had recurring episodes of bronchial asthma for one year. At the end of April 1942, an upper respiratory infection developed, which was followed by fever of 102° F., a non-productive cough, and loss of 12 pounds in weight over a period of four weeks. Interestingly enough, during this acute illness the asthmatic attacks ceased. Study at another clinic revealed extensive pulmonary infiltrates, and a diagnosis of active pulmonary tuberculosis was made. However, all examinations for confirmatory evidence of active pulmonary tuberculosis yielded negative results. Because of the unusual and, in a sense, characteristic roentgen appearance of the lungs, the blood was examined for eosinophilia and revealed 46 per cent eosinophilic leukocytes.

The patient made a gradual but uneventful recovery, with complete resolution of the pulmonary exudates about two and a half months after their first appearance. He has remained well.

CASE 4 (Fig. 4): This case is one of transient and recurrent pulmonary infiltrates appearing in the lungs of a girl of 19 with a blood eosinophilia up to 39 per cent. She came under our observation first in 1940, with a history of recurring bouts of asthma for three years. During the ensuing year she exhibited the following additional significant clinical

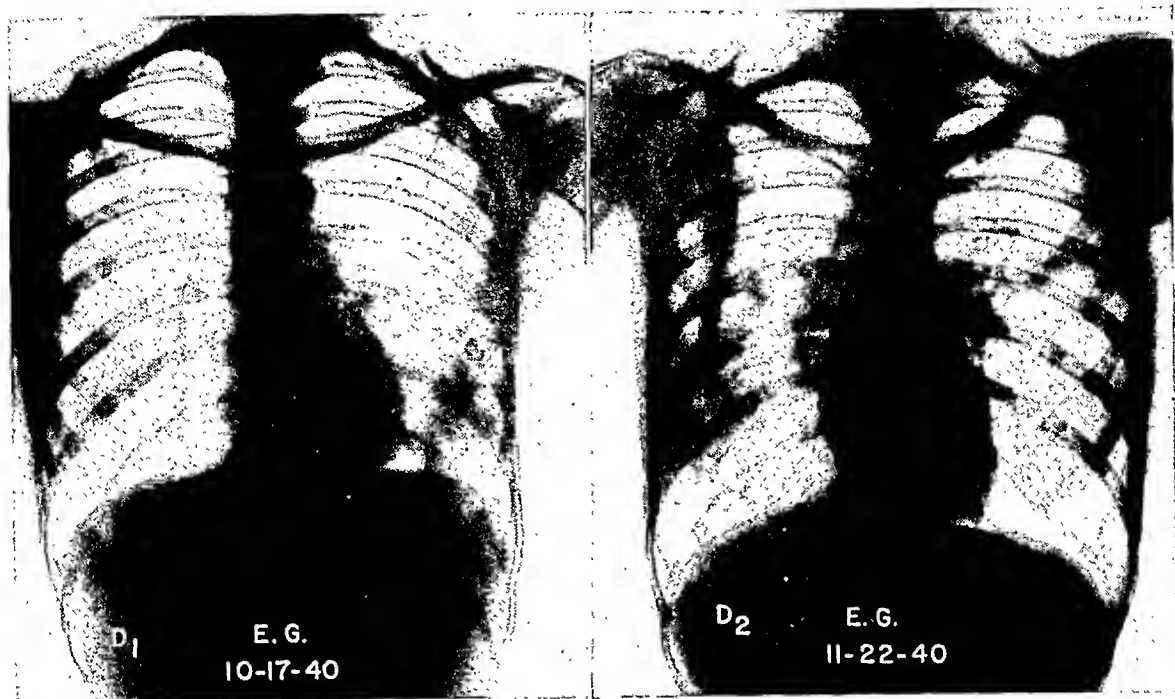


Fig. 4. Case 4. On Oct. 17, 1940, there were irregular exudative lesions in the left lower lung, within which was an oblique homogeneous streak. By Nov. 22, 1940, the left base was clear, but a similar lesion was present in the right chest.

manifestations: recurring episodes of asthma, abdominal pain, and bouts of diarrhea with five to seven watery stools a day, occasionally with mucus and blood streaks; eosinophils in the sputum; a small pleural effusion, with 85 to 100 per cent eosinophilic leukocytes in the fluid; pain and tenderness in the muscles later followed by weakness, paralysis, and purpuric spots on the skin. Electrocardiographic changes were suggestive of myocardial disease. Biopsy of a skin lesion showed eosinophilic infiltrations about blood vessels and nerves. Death was due to cardiac failure.

No necropsy was obtained in this case. In another case, however, with a practically identical clinical picture and course, the significant necropsy findings were as follows: eosinophilic infiltrations in the interalveolar septa of the lungs; endarteritis obliterans of the pulmonary blood vessels; diffuse eosinophilic infiltrations in the heart muscle, the intestines, and the abdominal muscles; diffuse involvement of small and medium-sized arteries in various organs, including such changes as intimal thickening, infiltration with many eosinophilic leukocytes, endarteritis obliterans, necrotizing arteritis, and periarteritis.

Case 4 thus illustrates the transition

from the simple variety of the so-called Löfller syndrome to the condition characterized as diffuse vascular disease.

CASE 5 (Figs. 5 and 6). L. C., a Puerto Rican woman of 26, was seen in June 1942, with a ten-year history of chronic sinusitis and a three-year history of recurring bronchial asthma. During the three months preceding admission, she had fever up to 102° F. and experienced numerous asthmatic attacks. On admission she showed widespread infiltrations in both lungs. A leukocytosis of 24,000 to 36,000 with 42 to 68 per cent eosinophils was found. The patient remained under observation until Feb. 1, 1943, during which time roentgenograms of the lungs showed alternating clearing and recurrence of the exudates. The cardiac shadow became larger. The eosinophilia fluctuated with the pulmonary changes. During the same period arthritic symptoms developed. Signs and symptoms of cardiac involvement appeared with recurring episodes of right heart failure and there were electrocardiographic changes indicative of myocardial damage. Tender nodules as large as a pea were palpable along the course of the blood vessels. Severe abdominal symptoms appeared, as well as variable neurological complaints. Asthmatic attacks continued to be frequent and severe. The general condition showed progressive deterioration. Biopsy of skin and muscle showed a necrotizing arteritis as seen in periarteritis nodosa.



Fig. 5. Case 5. On June 11, 1942, there were nodular and confluent infiltrations in the left upper lobe, at the root of the right lung, and in the right lower lobe. Thirteen days later, the left upper lobe and root of the right lung were practically clear, but the right lower lobe was involved more extensively.

In Case 5 the transient and recurring pulmonary exudates with eosinophilia occurring in an asthmatic patient originally led to a diagnosis of simple eosinophilic pneumonia. The subsequent course of the case indicated involvement of the joints, heart, and blood vessels elsewhere in the body, such as occurs in periarteritis nodosa.

#### ROENTGEN FINDINGS

In our experience, the eosinophilic infiltrations are of homogeneous density and varying size. They may be confluent, resulting in a patchy appearance or, if they are extensively confluent, resembling lobar consolidation. Sometimes there is an appearance of radiation from the hilum, but usually there are associated confluent patches at the periphery. Complete resolution usually takes place, but a few linear strands may remain. In this form, the roentgen appearance is not characteristic. Tuberculosis or suppurative bronchopneumonia may be simulated. Certain phases in the course of Boeck's sarcoid are also similar. Frequently during the progress

of the disease, however, narrow, plate-like homogeneous densities are seen extending obliquely caudad and laterally. Often they are symmetrical in the two lungs. They also resolve completely. Whether they represent localized exudations in the lung or in the pleura is impossible to state, but they seem to be unique to this disease. There is no predilection for upper or lower lobes, but a fair degree of symmetry on the two sides is the rule. Evidences of atelectasis, calcification, and cavity formation are entirely lacking. Nodular infiltrations where the nodules are of nearly equal size have not been seen by us but have been described by others. Hilar adenopathy is not apparent.

#### DISCUSSION

A brief discussion of etiology and pathogenesis of eosinophilic pulmonary infiltrations is of aid in an understanding of the roentgen findings. An allergic origin has been suspected by most observers. Löffler stressed the importance of tuberculotoxins but did not exclude the possibility of other allergenic factors. Leitner believed that

the fleeting pulmonary infiltrates with eosinophilia were hyperergic in character and were due to different causes, including allergic reactions about tuberculous lesions. *Ascaris* and amebiasis may furnish the specific allergens causing the symptoms in certain cases, while in others bacterial toxins, foods, or pollens may be the responsible factors.

Because of the benign character of most of the reported cases, there has been little opportunity to study at postmortem examination the nature of the pathological process in the lungs during the active phase. In some of the reported cases histologic examination of the bone marrow and of excised lymph nodes showed hyperplasia and infiltration with many eosinophilic leukocytes. The inference was drawn that the shadows in the lung were probably due to similar infiltration of the lung tissue with eosinophilic cells.

H. v. Meyenburg (6) had the unique opportunity to observe the postmortem findings in 4 cases with fleeting lung infiltrates during the active phase. Three patients died after accidental injury and one of acute tetanus. The gross appearance of the pulmonary foci was not characteristic. They resembled focal pneumonias of varying form, size, and distribution. Microscopically all these cases showed a high grade of eosinophilia in the inflammatory exudate. In 2 cases there was also an eosinophilic bronchitis and bronchiolitis. Charcot-Leyden crystals were found in one of the pulmonic infiltrates. Eosinophilia of the blood and bone marrow was present in all cases. In 2 of the cases eosinophilic infiltrates were found also in the liver.

In a series of reports under the title "Vascular Allergy" (4, 5), Harkavy described recently 16 cases which were observed for long periods of time and were studied with great care, including biopsy and postmortem observations. All of his cases showed eosinophilia and the transient pulmonary exudates which characterize the syndrome under discussion. Many of the cases, however, showed other interesting

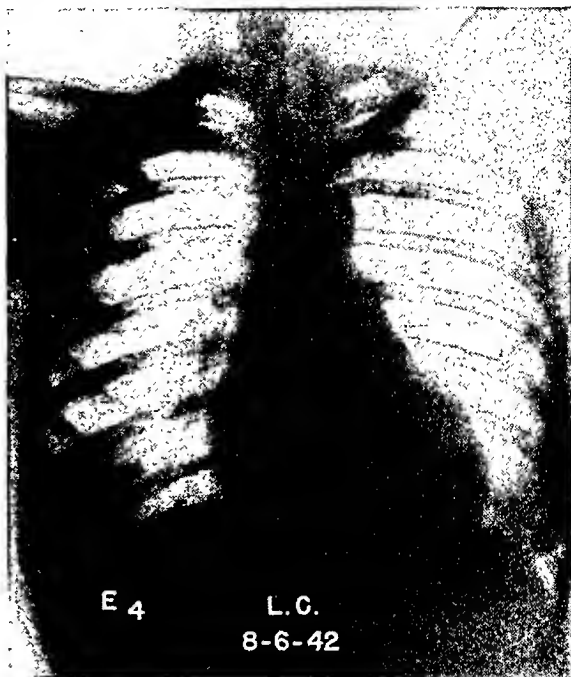


Fig. 6. Case 5. By Aug. 6, 1942, the lungs were practically clear, but the cardiac shadow was distinctly increased in size. There were associated episodes of right heart failure.

features, some of which were not previously described. An allergic background was present in all cases. The pulmonary infiltrates lasted for long periods, weeks or months instead of days, and in one case recurred as many as ten times. The associated clinical features were not always mild, and in some instances proved fatal. In many of the cases there were analogous exudative reactions in other tissues and organs, as the pleura, the pericardium, the peritoneum, the heart muscle, the skin, the joints. Examination of the pleural and peritoneal exudates showed 85 to 100 per cent eosinophils. Biopsy of skin lesions showed eosinophilic infiltrations as an important element of the lesion. Some patients died, and postmortem examination revealed eosinophilic infiltration in the lungs, heart muscle, and other organs involved, as well as various types of arteritis and periarteritis.

The roentgen findings in the chest can thus be attributed to an exudative reaction in the lungs and pleura, perhaps analogous in character to the wheal formation ob-



served in the skin. It is in this way that the homogeneous density of the scattered and oblique plate-like areas can best be explained.

#### SUMMARY

1. A description of the clinical and roentgen features of eosinophilic infiltrates in the lungs has been presented.

2. The resemblance of the pulmonary infiltrates to the lesions seen in exudative tuberculosis has led to an erroneous diagnosis of atypical pulmonary tuberculosis in many instances. The bizarre distribution of the pulmonary densities is quite characteristic and should suggest the correct diagnosis; the finding of an eosinophilia will confirm it.

3. These pulmonary infiltrates frequently resolve in a few days, but they may last for weeks and months. They may also recur many times.

4. There is a definite allergic background in most if not all of the cases, which suggests an allergic basis for this condition. A multiplicity of allergenic factors may be responsible for it.

5. The associated clinical features may be mild and of short duration. They may

also be of moderate severity and last for weeks and months.

6. In some cases there may be an analogous exudative reaction in other organs and tissues. A fatal issue may result if important organs are severely involved.

7. Recurrent and transient pulmonary infiltrates with eosinophilia may represent one manifestation or phase of vascular allergy (Harkavy).

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# Chronic Massive Pericardial Effusion Following Roentgen Therapy for Carcinoma of the Breast<sup>1</sup>

With a Case Report

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CHRONIC pericardial effusion following a single massive dose of x-rays appears to be extremely rare. We have not been able to find any reported case in an extensive search of the literature. The effects of irradiation on the heart and its coverings have been discussed by Leach (13) in a recent study of 85 cases and by Leucutia (14) in an editorial. These authors have reviewed the essential clinical and experimental findings.

Leucutia states: "For the present, we can safely make the premise that no damage is being done to the heart itself by the various methods of irradiation as currently used in roentgen therapy." While this generalization may normally be valid, complications arising from injudicious therapy must always be kept in mind. These possibilities may be explored with the aid of animal experiments and answered more fully by carefully recording observations of the effects of the rays on the patient. Close correlation of the clinical observations with the pathological findings is essential in cases in which doses massive enough to produce lesions of some magnitude have been administered. Thus will the appropriate critical tolerance dose which will not produce damaging changes be discovered.

We had the opportunity of observing the effects of a single massive dose of x-rays given in such a way that the minimum of tissue lay between the incident beam and the heart. The position and the body build (short and obese) of the patient brought the heart and its coverings to within 2 or 3 cm. of the measured surface treated. A short preoperative course was given, consisting of three treatments to-

taling 600 r (in air) to a circular field, 25 cm. in diameter, on the anterior left chest. The posterior axilla was treated with a single 300 r exposure to a 15-cm. circular field. At the time of operation a single dose, thought to be 3,000 r (in air), was directed to a 12 × 14-cm. area through the open wound. Review of the original treatment record leads us to believe that the exposure at the surface of the chest wall (flayed) may have been 3,600 r (in air). Estimating scattering and absorption, the tissue dose in the pericardium where it lay closest to the surface—2 to 3 cm.—may have reached 3,800 r. This tissue dose of 3,800 r given in one session is probably equal to a tissue dose of 7,600 r delivered in ten minutes over a ten-day period (Pack and Quimby, 16). Added to this single massive dose was a certain amount of radiation from the preoperative course (which undoubtedly included the left half of the cardiac area), an increment of perhaps 650 tissue roentgens in four days, or a total estimated tissue dose of 8,250 r in a period of nine days.

## CASE REPORT

On Aug. 22, 1939, a plump Korean woman of 53 years entered San Francisco Hospital complaining of masses in the left breast and axilla of one month's duration. The mass in the upper outer quadrant of the left breast measured 7 cm. in diameter and was attached to the skin and deep tissues. A large semi-fixed axillary node was palpated. The remainder of the physical examination and the laboratory findings showed nothing unusual except for a hypertension of 220/95. X-ray examination of the chest was negative (Fig. 1).

From Aug. 24 to Aug. 28, the patient received three doses of x-rays, a total of 600 r (in air), to a 25-cm. field including the left breast and axilla, at 70 cm., with 200 kv., and 0.5 mm. Cu and 1 mm. Al filtration (giving a half-value layer of 1.0 mm. Cu).

<sup>1</sup> From the Departments of Pathology and Radiology, Stanford University School of Medicine, and the Department of Public Health of San Francisco. Accepted for publication in July 1944.



Fig. 1. Roentgenogram made Aug. 24, 1939. The lungs are clear and the cardiac silhouette is not unusual. The bony thorax is intact.

She also received a single dose of 300 r to the posterior axilla (circular field 15 cm. in diameter) with the same factors.

On Sept. 2, a left radical mastectomy for medullary carcinoma of the breast was performed. During the operation the patient was exposed to a dose of approximately 3,600 r in air (time, 15 minutes; 12 X 14-cm. field; 40 cm. distance; 200 kv.; no filter; half-value layer 0.35 mm. Cu) for the purpose of "sterilizing" any residual cancer cells at the operative site. The x-rays were directed into the open wound on the left chest wall and axilla at the level of the 4th, 5th, and 6th ribs, the skin edges being protected by a thin sheet of lead. The patient was returned to surgery and the wound was closed. Following an uneventful recovery, she was discharged Oct. 7, 1939.

On March 27, 1940, the patient complained of cough with some tightness in the left shoulder and pain down the left arm. X-ray examination showed a shadow interpreted as roentgen pneumonitis (Fig. 2). The weight, not previously recorded, was 148 pounds.

On Oct. 9, 1940, abdominal distress was reported. The liver edge was palpated two finger breadths below the costal margin.

During the succeeding year the patient lost 25 pounds, and cough and abdominal discomfort persisted. On Oct. 15, 1941, exertional dyspnea was noticed for the first time. The liver edge was still palpable.

In the following two years all of the symptoms persisted and on Feb. 26, 1942, extensive mediastinal and pericardial metastasis was suspected (Fig. 3). There had been a steady loss of weight to 102 pounds.

On Feb. 5, 1944, the patient re-entered San Francisco Hospital suffering from abdominal distress, swelling of the legs, and exertional dyspnea. Physical examination showed a thin, dyspneic, middle-

aged woman with moderate venous distention in the neck. The mastectomy scar was smooth, and there was no evidence of a local recurrence of the tumor. There was dullness with decreased breath sounds over the left chest. The heart was enlarged to percussion to the left anterior axillary line. Occasional premature systoles and a rough systolic murmur were heard. The liver was felt three finger



Fig. 2. Roentgenogram made March 27, 1940, seven months after roentgen therapy. The consolidation of the upper half of the left lung is obvious. There is blunting of the left costophrenic angle. The right lung remains clear. There is no displacement of the trachea. The fullness of the cardiac shadow is clearly seen to the right as compared with the earlier film (Fig. 1). The left cardiac border cannot be clearly seen in this reproduction, but a dotted line has been used to show its location on the original film. The enlarged cardiac shadow was noted only in retrospect. The bony thorax is still intact. (Note in this and the subsequent reproductions the descent of the leaves of the diaphragm as the patient loses weight.)

breadths below the right costal margin. There was pitting edema of the lower extremities and sacral region. The blood pressure was 170/100. The ECG showed a P-R interval of 0.17 seconds; slurring and low voltage of QRS in all leads but normal duration; ST 1, 2 and 4 depressed 1 mm. with small upright T 1, 2 and 4; ST 3 isoelectric with almost flat T 3. The electrocardiographic findings were interpreted as indicative of mild myocardial damage.

On bed rest, the edema decreased and the circulation time fell from 35 seconds on Feb. 6 to 20 seconds on Feb. 14. On Feb. 18, the condition changed suddenly for the worse and respiration became grunting. The venous pressure was recorded at 18 cm. of water, and the circulation time increased to 27 seconds. An ECG showed no change from previous findings.

On March 10, 1944, the blood pressure was 115/75 and the neck vessels were dilated and pulsating. On



Fig. 3 (left). Roentgenogram made Feb. 26, 1942, two and a half years after irradiation, showing slight diminution in the consolidation of the left upper lobe. The blunted left costophrenic angle persists. The trachea remains unchanged. The cardiac silhouette is now tremendous, extending far to the right of the mid-line. It was thought at the time that the patient was suffering from metastatic carcinoma. Now for the first time the thinning of the ribs along the lateral chest wall is demonstrated.

Fig. 4 (right). Roentgenogram made March 10, 1944, four and a half years after irradiation. The film reveals no great change in the airless upper half of the left lung and the costophrenic angle. The right lung now shows increase in the vascular markings and areas of patchy consolidation. The cardiac silhouette has a typical "water-bottle" appearance and extends from 1.5 cm. within the left chest wall to within 2 cm. of the right chest wall. Six of the atrophied ribs show fractures—the 2nd, 3rd, 4th, 5th, 6th, and 7th.

the following day the patient was in shock, with a blood pressure of 84/68, pulse rate of 110, and faint heart sounds. A pericardial tap removed 310 c.c. of brownish fluid, which was under considerable pressure and clotted almost immediately; this was replaced by air (Fig. 5). Death occurred within two hours following the tap.

*Autopsy:* At autopsy the borders of the pericardium were found at the right midclavicular line and the left anterior axillary line. There were 350 c.c. of serofibrinous fluid in the left pleural cavity. Fractures of the 2d rib anteriorly and 3d, 4th, 5th, 6th, and 7th ribs laterally were present. The pericardial sac was distended with 300 c.c. of fluid and air. The parietal pericardium was dilated and thickened (2 to 3 mm.) by opaque fibrous tissue, and wrinkled on its inner surface, giving the appearance of elephant skin (Fig. 6). It contained 2 small opaque nodules 1-2 mm. in diameter. The visceral pericardium showed less thickening and there was a distinct difference between the thickness of the left anterior portion and of the right posterior area. The heart weighed 320 gm. The myocardium was tough throughout, although no gross fibrosis was seen. The left lung was small. The upper lobe and the upper part of the lower lobe were composed, principally, of bronchi and vessels separated by only a small



Fig. 5. Roentgenogram made March 11, 1944, after removal of 310 c.c. of pericardial fluid and replacement with air. The film reveals the large thick-walled pericardial sac. The patient died within two hours following the tap.

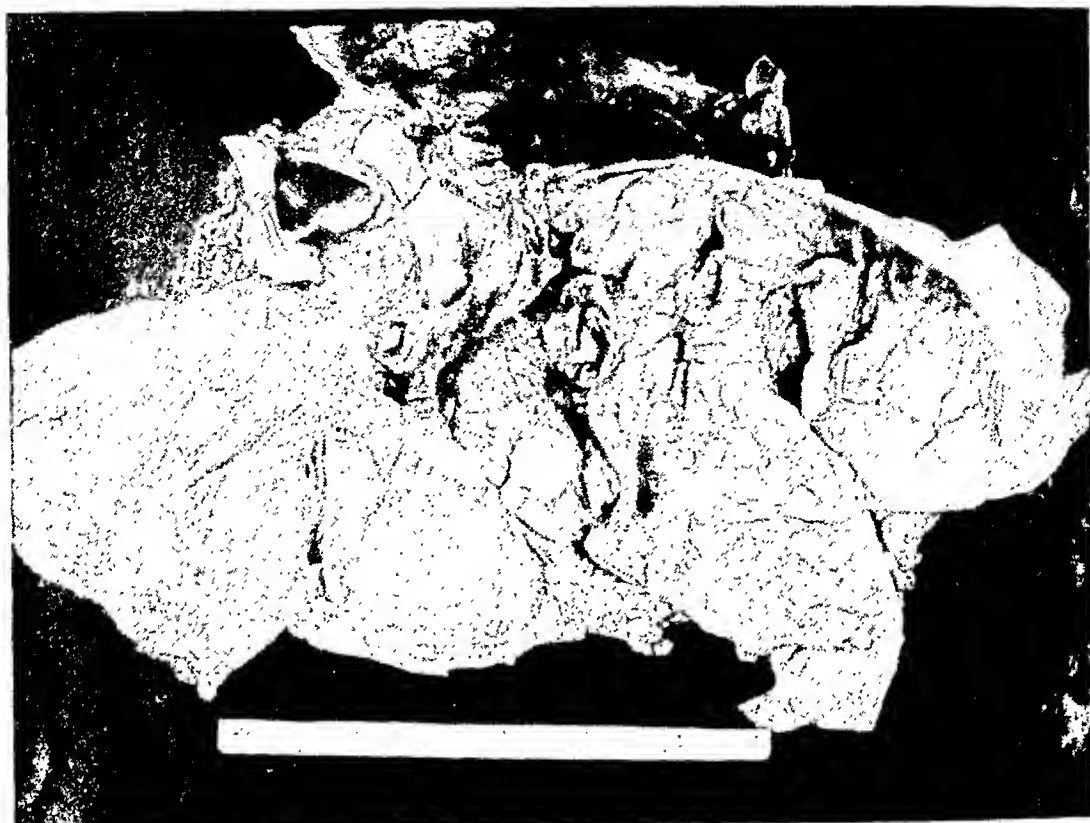


Fig. 6. Excised parietal pericardium showing thickening and wrinkling which produce the superficial appearance of elephant skin.

amount of collapsed lung tissue. Bronchopneumonic consolidation was present in the right lung and left lower lobe.

Microscopically there was widespread focal fibrosis of the myocardium in all the chambers of the heart, most marked in the left auricle and ventricle. Some of the coronary artery radicles showed intimal proliferation but others showed none. The pericardium contained much dense hyalinized fibrous tissue in the parietal and visceral layers; in places small dilated thin-walled vessels were prominent. The fibrosis of the visceral pericardium was more marked on the left. In two nodules seen grossly there was evidence of old hemorrhage. A number of large discrete fibroblasts with large, bizarre, somewhat irregular deeply stained nuclei were seen in the fibrous tissue of both the pericardium and myocardium. The upper lobe and upper part of the lower lobe were almost completely collapsed. Their substance was firm, and histologically there was much thickening of the alveolar septa, where elastic tissue was abundant. There was mild diffuse increase in fibrous tissue and some large fibroblasts similar to those described in the myocardium and pericardium were seen in the lung and pleura. Many small vessels were dilated, and several medium-sized branches of the pulmonary artery contained canalized thrombi. Acute bronchopneumonia was present in both lungs.

The pleura showed fibrous thickening with superimposed acute inflammatory reaction. Sections of the ribs at and adjacent to the fracture zones revealed fibrous replacement of bone marrow, with atrophy of the cortex and bone spicules.

It was concluded that the remarkable fibrous thickening of the pericardium which showed no specific inflammatory reaction was probably the result of the unusually intense irradiation of this region at the time of the left mastectomy. The mechanical interference with the heart movement was the principal cause of circulatory failure and the final illness. The left lung was extensively collapsed, presumably as a result of irradiation, although fibrosis was not marked. No tumor was found.

#### COMMENT

The literature abounds with references (Warren, 19; Desjardins, 3) to the changes in the myocardium following irradiation, but heretofore only passing mention has been made of the occurrence of small effusions and the effects of irradiation on the pericardium (Freid and Goldberg, 6; Davis, 2; Hartman *et al.* 11). Granzow (10)

is the only investigator who has described changes in the pericardium similar to those in our case. He emphasizes the necrotizing effect of the rays upon the pericardium in guinea-pigs.

The exact mechanism of the development of pericardial effusion in our case cannot be determined, but, for the following reasons, it appears to have resulted directly or indirectly from the irradiation: the amount of radiation reaching the pericardium in a short time was large; the pathological changes were unusual and included telangiectases in the scar as well as an alteration in fibroblasts similar to that frequently reported in radiation reactions (Maximow, 15); there were associated changes in the ribs and in the left lung compatible with a roentgen reaction; the changes have a counterpart in the experimental observations of Granzow (10), Davis (2), Hartman and others (11) in irradiated animals; finally, no other satisfactory explanation for the changes has been found. One factor may have been the occlusive effect of x-rays upon the lymphatics (Gassmann, 7 and 8) and blood vessels (Baermann and Linsen, 1). The damage to the parietal pericardium, in view of the fact that this structure plays the greater part in absorption of fluid from the pericardial cavity (Henke and Lubarsch, 12), appears to be a significant factor in the production and persistence of the massive effusion. The occurrence of bizarre fibroblasts (Maximow, 15) confirms the direct effect of the x-rays upon the pericardium. The greater degree of damage (fibrous thickening) of the left side of the visceral pericardium as compared to the right is in correspondence with the greater severity of myocardial lesions on the left, *i.e.*, in the path of greatest intensity of the x-rays, which were directed obliquely from left to right.

The histologic observations on the myocardium conform to the microscopic experimental and clinical findings described by Warthin and Pohle (20 and 21); Freid and Goldberg (6); Davis (2); Granzow (10); Werthemann (22), and Domagk (4).

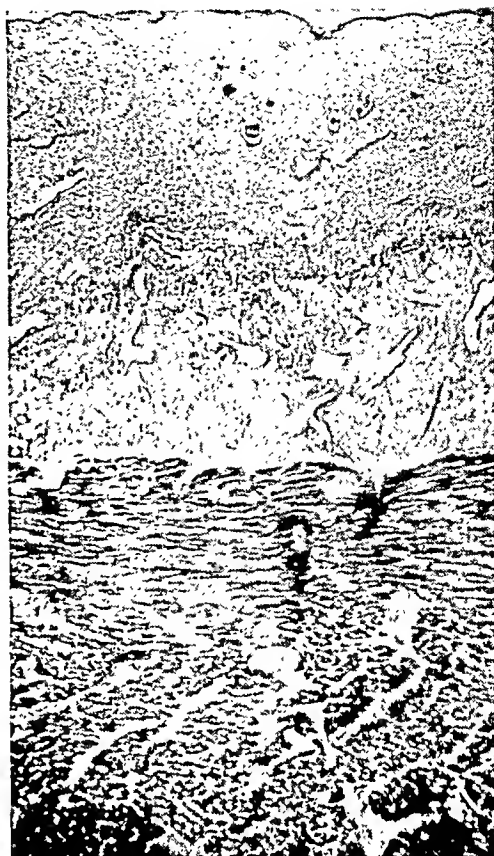


Fig. 7. Photomicrograph of left ventricle, showing fibrous thickening of the visceral pericardium to 2 to 3 mm. A narrow border of epicardial fat remains, but here also fibrosis is seen. The irregular blurred appearance of the myocardium is due to the patchy character of the fibrosis. Azocarmine-aniline blue stain.  $\times 65$ .

All report varying degrees of myocardial damage, with emphasis on the patchy character of the changes originally described by Schweizer (18), who believed that the microscopic picture is specific. Our findings are at variance with the conclusions reached by Gordon *et al.* (9), Emery and Gordon (5), and Leucutia (14), denying a significant effect of x-rays upon the myocardium. The possibility that the changes in our case might have been on the basis of long standing pericardial effusion, with compression of the heart, has been taken into consideration. Roberts and Beck (17), however, investigated the effect of long standing constriction on the heart and observed only atrophy of the heart muscle fibers.

## SUMMARY

A case of pericardial effusion of four and a half years' duration following a single massive dose of x-rays is presented, with autopsy findings.

The treatment was through an open mastectomy wound. The total estimated dose in the pericardium was 8,250 tissue r.

The pathological changes in the heart, especially the pericardium, are described and discussed.

Damage to the parietal pericardium is believed to have been a significant factor in the production and persistence of the effusion.

## CONCLUSIONS

This appears to be the first reported case of massive pericardial effusion of long duration, following irradiation.

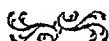
Chronic pericardial hydrops can be produced by a single massive dose of irradiation to the opened thoracic wall. This hydrops can be of such severity as to be the primary cause of death.

Massive irradiation of the open thorax (as a step in the control of mammary and other neoplasms) with the doses employed in this case is not to be recommended.

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# Observations on Over One Hundred Cases of Myelogenous and Lymphatic Leukemia

With Blood and Sternal Puncture Studies and Follow-Up of Several Years<sup>1</sup>

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THE LEUKEMIAS constitute a subdivision in the group of reticulo-endothelial neoplasias and present symptoms and clinical features which closely parallel those of the entire group. In order of the approximate frequency of their appearance, the reticulo-endothelial neoplasias can be listed as follows:

1. Leukemias (myelogenous, lymphogenous, monocytic, etc.)
2. Lymphosarcoma, including reticulum-cell sarcoma, large- and small-cell lymphosarcoma.
3. Malignant lymphadenoma or Hodgkin's disease.
4. Multiple myeloma, plasma-cell myeloma.
5. Endothelioma.
6. Ewing's tumor or endothelial myeloma of bone.
7. Tumors of the storage reticulum, including Niemann-Pick disease, Schüller-Christian's disease, Gaucher's disease.

Except in the case of the storage-cell tumors, the life expectancy, type of morbidity, and response to radiation or drug therapy follow a closely similar pattern in all these diseases, though there are numerous individual variations by virtue of which the subclassifications have arisen. In the well established individual groups, the morphologic picture as seen on microscopic section is characteristic for each group. These groups, however, so overlap histologically that frequently at some time during their respective courses they are

histologically inseparable. This becomes particularly evident when an attempt is made to interpret lymph node biopsy in the lymphosarcoma or leukemia groups without foreknowledge of the blood picture. The use of bone marrow studies as a routine procedure has been a valuable aid in separating the lymphosarcomas from the leukemic cases.

The etiology of leukemic disease is entirely unknown and therefore there is no specific treatment. For a limited period of time the manifestations may be more or less localized but eventually, if the patient survives long enough, the condition will become generalized. This general distribution of the disease is not an instance of metastasis but one of multiple spontaneous manifestations. The existence of reticulo-endothelial cellular elements in practically every part of the body permits the development of the specific lesions within any of its structures. We therefore see leukemic nodular infiltration in the skin, in bone, in fascial planes, in any and all the viscera, in muscle structure, in the mucosa of the mouth, vagina, endometrium, etc.

This widespread distribution of disease is important in considering radiation therapeutic procedure. The dosage must remain as small as is compatible with relief of symptoms. Nothing is gained by over-irradiation. It is not unusual to see radiation resistance developing in a case that has been excessively irradiated. The indications for treatment by radiation, or by drugs, or by transfusion, are purely palliative. Pressure from enlarged lymph nodes

<sup>1</sup> From the Radiation Therapy Department, Kings County Hospital, Department of Hospitals, New York City. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

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and pain from splenic enlargement or from bone infiltration point to the need for irradiation, as do malaise, easy fatigue, weakness, and moderate temperature elevation. Symptoms of nitrogen retention, varying from malaise to the pre-uremic or uremic state, are helped by irradiation of the kidneys, through reduction of the leukemic infiltration of the renal parenchyma and the incident mechanical embarrassment of the glomeruli and tubules. Nemenow, Jugenberg *et al.* demonstrated an increase in uric acid excretion after kidney irradiation in advanced leukemia and described a uric acid index. A pronounced leukopenic blood picture is a contraindication to irradiation. An acute leukemic blood picture is not favorably influenced by radiation. The value of the leukocyte count in the saliva, as described by Isaacs, could not be borne out in our study.

In the series of cases reviewed, the bone marrow in the majority of instances was studied repeatedly. All examinations were made by the aspiration method made popular by Vogel, Erf, and Rosenthal. Briefly, this consists, in adults, of withdrawing about 1 c.c. of marrow from the cavity of the sternum at the level of the third interspace. Total nucleated cell and megakaryocyte counts were made and differential smears examined. In children, the tibial marrow cavity was used, since this presented less difficulty. In addition, it was found that the tibial space is larger in children than that of the sternum and the possibility of injury to the underlying structures is therefore less. A careful survey of all our material to date indicates that in every case of leukemia coming to our attention the bone marrow of the sternum or tibia was involved to the extent that there was never any question of diagnosis. While it is true that some of our patients were brought to us in late or terminal stages, there were many others in whom the diagnosis was made only after blood and marrow studies. This suggests that the bone marrow must be involved before the disease becomes clinically manifest. Several cases included in this study were

referred to the Hematological Clinic of the Radiation Therapy Department with a biopsy diagnosis of lymphosarcoma and indefinite peripheral blood counts only to be proved, first by sternal puncture and later by the course of the disease, to be lymphatic leukemia. We are impressed by the probability that the marrow picture will prove to be the earliest and most accurate factor in the differential diagnosis.

The lymphocyte count in the sternal bone marrow in lymphatic leukemias varied between 23 and 96 per cent of all the white blood cells present. The normal bone marrow shows from 8 to 13 per cent lymphocytes. Cases believed on biopsy to be lymphosarcoma but showing bone marrow lymphocyte counts of 23 per cent or more proved subsequently to be lymphatic leukemia.

Bone-marrow studies are an essential part of the investigation of the reticulo-endothelial diseases not only for the diagnosis of lymphatic leukemia but also for the recognition of several other diseases in this general group. Plasma-cell myeloma and Gaucher's disease can be recognized rather simply on bone-marrow puncture.

This review is based on 105 cases of leukemia seen between 1939 and 1941 in the Radiation Therapy Department of Kings County Hospital. Of these cases, 51 were lymphatic leukemia and 53 were myelogenous leukemia; 1 was a monocytic leukemia.

The 53 cases of myelogenous leukemia were about evenly divided between males and females. Eleven cases were hematologically and clinically acute; 42 cases were chronic. Patients with acute myelogenous leukemia survived an average of 2.5 months from the onset of illness. The longest survival was nine months, the shortest about two weeks. All the cases in children were acute, but the majority of acute leukemias are not in childhood. The average age of the patients with acute myelogenous leukemia was thirty-six years; the youngest was five years and the oldest seventy-five years of age. Of the 42 patients with chronic myelogenous leukemia, 8 are still alive. For those who died, the average

duration of illness from first symptom to death was 44.2 months. The shortest duration was eight months. Two patients survived more than six years, 3 eight years, and 1 over eleven years. The patients who are still alive are in no sense cured. They still show the blood picture and symptoms of their disease.

The lymphatic leukemias, 51 cases, were found almost twice as frequently in males as in females. Five of the cases were hematologically and clinically acute; 46 were chronic. In the acute cases the average duration of life was 4.4 months from the onset of illness. The youngest patient was eleven years old, the oldest seventy-two years. Of the 46 patients with chronic lymphatic leukemia, 10 are still alive and several of them are in the seventh year of illness. The average survival period for those who died of the disease was seventeen and a half months. This is considerably less than the expectancy in chronic myelogenous leukemia. Except for the relief of mechanical pressure symptoms which threaten life, as for instance a mediastinal mass causing dyspnea or renal infiltration causing uremia, the length of survival is not directly attributable to variations in the type of radiation therapy used.

The treatment of leukemia falls into three main categories: transfusions, drug therapy, and irradiation. The condition of the patient dictates the type of treatment. The patients with clinically mild leukemia, generally comfortable, not particularly anemic, and without definite presenting symptoms, are treated by intelligent observation. In the absence of a specific for the disease and without need for palliation, such a patient is to be encouraged and his

illness made light of. As anemia appears, the liberal and frequent use of blood transfusions is recommended.

Radiation therapy as used in this series was either administered locally to the spleen or lymph node masses or to multiple fields over the long bones, or total body spray irradiation was given. The factors used were 200 kv., 0.5 mm. copper and 1.0 mm. aluminum filtration, 50 cm. focal skin distance for local fields and 150 cm. for spray irradiation. Local radiation therapy to lymph nodes or spleen was used to reduce pressure symptoms. The dosage was always small, usually a 150 to 200 r tumor dose to each area treated. The dose should be kept low and repeated only if and when local findings require it. Bone irradiation is recommended in moderately active cases without severe local pressure symptoms; 300 r is given to each of the long bones in rotation, one area being treated per day. This is repeated until each field has been given 600 r. The drop in the white blood cell count following such treatment was found to be more gradual than when the spleen was irradiated. Also, the clinical intermissions were longer following osseous irradiation. Total body irradiation was used in the advanced generalized cases and in those which had previously been treated locally but had become widespread. Because of the great amount of tissue treated, the dose must be kept small. Usually 33 r were given per treatment, rarely 50 r, but never more. The fall in the white blood cell count is very rapid and must be carefully watched before spray irradiation can be repeated.

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# Ileocecal Tuberculosis<sup>1</sup>

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THE DIAGNOSIS of ileocecal tuberculosis requires roentgenologic confirmation. From the experience at the Triboro Hospital for Tuberculosis, it is felt that the roentgen findings are sufficiently constant to permit this diagnosis to be made with some degree of certainty.

The problem at this hospital is simplified since all patients are presumably suffering from tuberculosis. The finding of organic lesions of inflammatory nature in the ileocecal region in a tuberculous patient is strong presumptive evidence that the process here is also tuberculous. The roentgenologic task, therefore, resolves itself into determining whether organic inflammatory disease is present. A differential diagnosis must, of course, always be made. We have found, however, that other conditions may readily be ruled out by the roentgen evidence. In the random case seen in a general hospital the problem would certainly be more difficult. Nevertheless, our experience would suggest that the roentgen findings may be sufficiently constant to indicate the diagnosis under any circumstance. If the patient is known to have tuberculosis, the presumption is stronger. As a corollary to this, chest roentgenograms would be indicated in the differential diagnosis of obscure ileocecal disease.

No discussion of the clinical syndrome will be given. It is to be noted, however, that there is a wide variation in the signs and symptoms. Even in the clear-cut cases, abdominal pain is of varying constancy and intensity. Indeed, it is not uncommon to find extensive ileocecal tuberculosis at autopsy in a patient who has had no gastro-intestinal symptoms or whose other complaints were so great as to

overshadow completely any abdominal manifestations. The pain, when present, is usually greatest in the right lower abdominal quadrant. On palpation, tenderness about McBurney's point is often found, although the pain may be more generally distributed. A tumefaction is occasionally present. In some cases this may be palpated only during attacks of pain, suggesting a transient volvulus at the ileocecal valve. The diagnosis of acute appendicitis requires exclusion. Diarrhea may be present in varying degrees, and occasionally the stools are bloody. Cultures of the stools may be negative for acid-fast bacilli. In one patient a search for the cause of a rapid pulse led to the discovery of extensive ileocecal disease which was giving no symptoms. The varying and uncertain clinical picture increases the diagnostic value of the roentgen study.

Direct roentgen evidence of organic disease is sought in the terminal ileum, the ileocecal valve, and the cecum. Indirect confirmatory evidence is furnished by the remainder of the ileum, the appendix, and the remainder of the colon, all of which may be involved. Important evidence is likewise contributed by the psoas shadows; the right psoas shadow is frequently obliterated, possibly by regional lymph nodes or tumefaction. An associated amyloid disease or hematogenous spread may be reflected in an enlarged spleen or liver, both of which can be seen on abdominal roentgenograms.

The method of examination includes hourly fractional studies of the small intestine, continued until the ileocecal region is clearly visualized. In one instance we were not able to demonstrate the terminal ileum well until the tenth hour. Barium

<sup>1</sup> From the service of Dr. A. L. Bachman, now serving with the Armed Forces. From the Department of Hospitals, City of New York. Accepted for publication in June 1944.

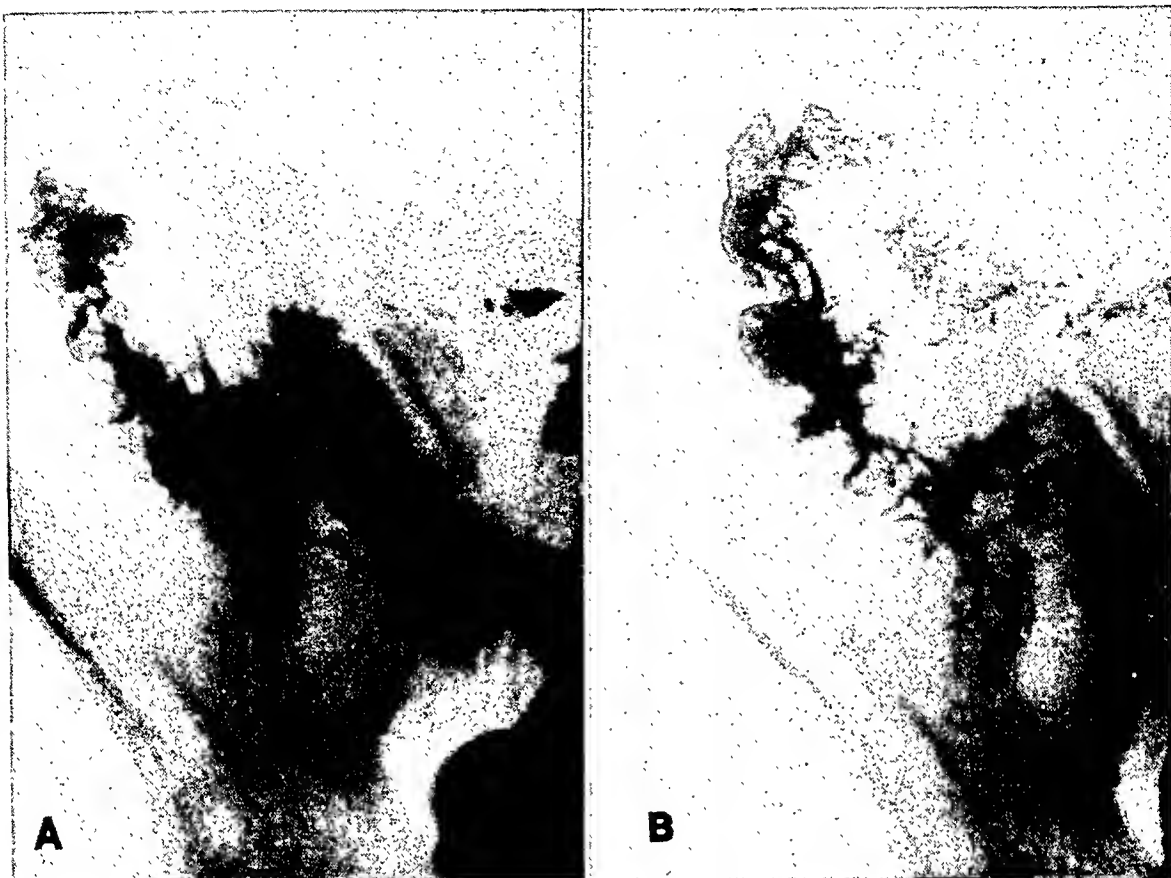


Fig. 1. Case 1: H. B., a 47-year-old female with active pulmonary tuberculosis of at least two years' duration, was referred with a diagnosis of ileocecal tuberculosis and amyloid disease. At autopsy scattered ulcers were found in the jejunum and ileum. These were closer together and more extensive in the terminal ileum; they involved the ileocecal valve and were present in the cecum. In the colon scattered ulcers extended beyond the sigmoid.

A. Roentgenogram made four hours after administration of barium by mouth, showing a cone-shaped terminal ileum with straightened, rigid walls. The cecum is spastic and deformed. The appendix, seen just below the ileum, has an irregular lumen.

B. At six hours the terminal ileum is demonstrable by its irregular, deformed lumen. The cecal spasm and deformity are more plainly shown. The appendix is fixed and deformed.

enema studies are also employed. With this procedure, the post-evacuation picture is frequently more informative than that of the barium-filled bowel. Fluoroscopy is a valuable aid. Air contrast studies are occasionally done. Spot-cone studies of the area are helpful.

#### ROENTGEN SIGNS AT THE TERMINAL ILEUM

The terminal few centimeters of the ileum are most frequently involved. The roentgen manifestations vary in degree with the extent and severity of the disease. Simple transient spasm may characterize very early involvement. A slight but definite mucosal pattern irregularity may be noted. Later the more typical findings

are seen. There is a narrowing of the terminal portion of the ileum, sometimes with some irregularity of the wall contour. In many cases, however, the narrowing appears to be associated with a straightening and rigidity of the walls. The narrowing of the terminal ileum is frequently wedge-shaped or conical (Figs. 1, A; 2, A, B, C; 3, A, B, C; 4; 5, A), the point of the cone facing toward an irregular ileocecal valve or into the prominent lips of the valve (Fig. 5). This cone shape may be better demonstrated during fractional studies of the intestinal tract than during barium enema studies. It is best seen when there is a pressure head dilating the terminal ileum. When this area is not



Fig. 2. Case 2: R. G., a 19-year-old white female with far advanced active pulmonary tuberculosis, complained of abdominal pain and soreness, especially in the right lower quadrant. There was tenderness to palpation over the ileocecal area.

A. Barium enema study revealing a cone-shaped deformity of the terminal few centimeters of the ileum. The mucosal pattern is lost, and the walls are straightened. The cecum is grossly deformed.

B. Post-evacuation film, clearly demonstrating the cone-shaped rigid deformity of the terminal ileum. Note, also, the gross deformity of the cecum.

C. The same area six hours after administration of barium by mouth. The cone-shaped rigid terminal ileum is seen, and severe cecal spasm is demonstrated.



Fig. 3. Case 3: J. H., a 47-year-old white male with active pulmonary tuberculosis, complained of abdominal pain and diarrhea. The pain was most severe in the right lower quadrant, where a mass the size of an orange was palpable.

A. Barium enema study showing cone-shaped deformity of the terminal few centimeters of the ileum and its straightened, rigid walls. There is some spasm in the cecum. An irregular, fixed appendiceal shadow is faintly visible below the ileum.

B. Post-evacuation film revealing delayed emptying of the ileum, with some dilatation proximal to the valve. The deformity and rigid appearance of the terminal ileum are constant. The irregular appendiceal shadow is faintly visible. The cecal spasm is more pronounced.

C. The same area six hours after administration of barium by mouth. Note the "ironed-out" appearance of the terminal ileum and its loss of mucosal pattern.



Fig. 3. Case 3: D. Absence of the right psoas shadow; string-like appearance of the terminal ileum.

distended, the terminal ileum may appear as an irregular linear or string-like shadow (Figs. 1, A; 3, D; 5, C; 7, A). At times during the barium enema study, very little barium can get by the diseased valve, and the terminal portion of the ileum will be seen as a narrow string (Fig. 5, C). More evidence can be obtained from an unchanging appearance, as demonstrated by several exposures. Normally, peristaltic movement should change the pattern of the terminal ileum. An unchanging bizarre picture speaks for the existence of an organic lesion.

With more advanced disease, as described above, the mucosal pattern of the terminal ileum is usually completely disrupted. The crater of a tuberculous ulcer may be seen (Fig. 5, B). Occasionally spasm may render the ileum invisible (Fig. 6) on the random picture studied.

*Summary of Signs at the Terminal Ileum:*

1. Transient spasm (early)
2. Mucosal irregularity (early); loss of mucosal markings (late)
3. Narrowing



Fig. 4. Case 4: H. N., a 48-year-old white male with active pulmonary tuberculosis, died of tuberculous meningitis. While in the hospital, he complained of cramps and diarrhea, and the lower abdomen was tender. At autopsy, ulcerations were discovered in the terminal ileum, cecum, and ascending colon. One ulcer appeared to be healing, with contraction.

Note the prominence of the ileocecal valve with slight invagination of the ileum. The cecum is spastic.

4. Irregularity of the walls
5. Straightening and rigidity of the walls
6. Cone-shaped terminal portion
7. String-like appearance of the ileum
8. Loss of normal changes in appearance on serial exposures
9. An ulcer crater

ROENTGEN SIGNS

AT THE ILEOCECAL VALVE

The ileocecal valve itself may appear as a negative shadow impinging upon the barium-filled cecum. The normal valve may be demonstrated in some patients. However, an edema or inflammation from any cause may make it more easily visible. Golden (1), in an interesting communica-





Fig. 5. Case 5: A. S., an 18-year-old white male, had advanced pulmonary tuberculosis. Though there were no gastro-intestinal symptoms, roentgenograms show indisputable ileocecal tuberculosis. This condition was discovered during an attempt to establish the etiology of a rapid pulse. The absence of clinical symptoms is a not unusual occurrence in this disease.

A. The roentgenogram taken two and a half hours after ingestion of barium shows extensive ileocecal tuberculosis, with ulceration throughout the entire ascending and transverse colon.

B. Detail view of ileocecal region, showing cone-shaped, rigid deformity of the last few centimeters of the ileum. The valve itself is prominent. The walls of the cecum are stiff and have a mouse-bitten contour. An ulcer niche can be seen in the ileum.

C. Barium enema study showing the same findings. Retrograde ileal filling was poor, and the terminal ileum appears as a rigid string. Note the large shadow defect produced by the ileocecal valve.

tion, recently called attention to this phenomenon. Strömbeck (2) states that the mucosal swelling in non-specific terminal ileitis is most pronounced near the valve, the two lips of which may be considerably swollen, and may bulge into the cecum. Ileocecal invagination may be related to this. A normal picture may occasionally be confusing, but when the valve is really enlarged, a pathological interpretation should be rendered. While this finding is by no means specific, it is frequently seen in ileocecal tuberculosis (Figs. 4 and 5). The conical narrowing of the terminal ileum appears, at least in part, to be due to edema and disease at the valve itself. The conical shape of the ileum should therefore be associated with other evidence of ileal disease before a pathological diagnosis of ileal disease *per se* is made.

Disease at the valve itself is reflected in functional disturbances as well as in improved visualization. The valve and terminal ileum may be gaping, with no re-

sultant delay in the passage of contrast substance beyond this point. When the rigidity does not result in a gaping opening, inflammation, spasm, and scarring may cause delay or partial obstruction. An interesting phenomenon sometimes noted is the closure of the valve during the course of a high-pressure barium enema. With evacuation, however, the valve spasm relaxes transiently and some cecal content spurts into the terminal ileum. This is occasionally observed normally, but in the tuberculous cases the spasm returns and roentgenographic study now reveals a spastic valve with barium in the ileum, which is slightly distended proximal to the valve (Fig. 3, A and B). The cecum is not distended.

#### *Summary of Signs at Ileocecal Valve:*

1. Increased valve visibility
2. Gaping valve with no evidence of obstruction
3. Delay or obstruction at valve
4. Regurgitation with obstruction

## ROENTGEN SIGNS AT THE CECUM

The appearance of the cecum is likewise predicated upon the duration and severity of the lesion. The mucosal pattern may show a definite irregularity, but this may vary only slightly from the normal contiguous areas. There may be a hyperplastic prominence of the mucosa with a corresponding coarsening of the pattern (Fig. 7, A), or there may be a severe disruption of the pattern (Fig. 6). The shape of the cecum may be disturbed by spasm or organic changes (Figs. 1, 2, 3, 6). The sign described by Stierlin, which consists of a gap in the cecal shadow when the ileum and colon are filled, is occasionally seen, but it is neither sufficiently specific nor constant to be considered pathognomonic. The contour of the cecum may be somewhat stiffened. The mouse-eaten edge of ulcerative colitis may be observed (Fig. 5). The negative shadow within the cecum produced by the ileocecal valve is sometimes a prominent finding (Figs. 4 and 5). At other times a combination of spasm and organic disease results in a complete loss of the usual appearance (Fig. 2).

*Summary of Signs at the Cecum:*

1. Mucosal irregularities
2. Spasm and deformity of shape
3. Stierlin's sign
4. Contour changes
5. Negative shadow caused by ileocecal valve

## INDIRECT ROENTGEN SIGNS

*Appendix:* The proximity of the appendix to this area makes its occasional involvement inevitable. Although a diseased appendix is notoriously difficult to diagnose by roentgenographic methods, nevertheless the findings are frequently suggestive. There is an irregularity of contour, and at times the actual niche of an ulcer may be seen (Fig. 7, B). At other times there is a gross and constant irregularity of the appendiceal outline (Figs. 1, 3, 7, B). Frequently the appendix may be shown to be fixed in an abnormal position.

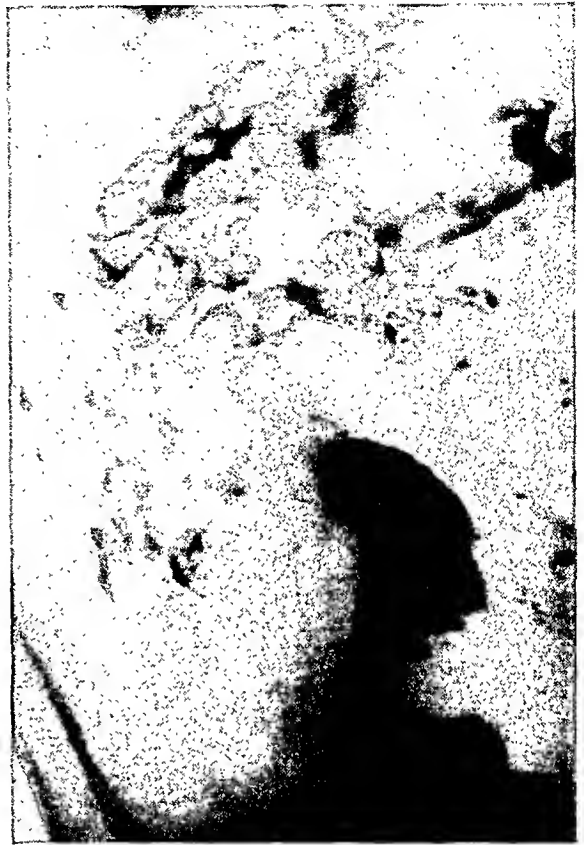


Fig. 6. Case 6: H. S., a 23-year-old white male, died of pulmonary tuberculosis. His gastro-intestinal complaints included an episode of abdominal pain over McBurney's point. At autopsy, many small superficial ulcers were found scattered over the terminal ileum and cecum. Amyloid disease was present.

The roentgenogram made six hours after administration of barium by mouth shows gross disruption of the mucosal pattern. The ileum was not demonstrable. These findings would indicate the need of additional study.

*Other Parts of the Colon and Ileum:* Multiple lesions in the colon and ileum are the rule rather than the exception. Occasionally definite sites of disease may be demonstrated elsewhere in the colon (Fig. 7, C). These would tend to corroborate a diagnosis of ileocecal tuberculosis as differentiated from neoplasia or other disease.

While it is true that the number of lesions increases as the ileocecal valve is approached, many ulcers are found scattered along the jejunum and ileum. It is difficult to distinguish the resultant segmented and fragmented appearance of the bowel from a deficiency pattern, especially since so many of these patients actually do suffer

A

B

Fig. 7. Case 7: G. K., a 41-year-old white male with active pulmonary tuberculosis of at least a year's duration, complained, for six months before death, of abdominal cramps and diarrhea. Ileocecal tuberculosis and amyloid disease were found at autopsy. The terminal few centimeters of the ileum were ulcerated and narrowed, with a slight thickening of the walls. The cecum was retracted, moderately thickened, and ulcerated. The appendix was retrocecal and severely ulcerated.

A. Post-evacuation barium enema study. The colon showed several extensive girdling ulcers. Theularity of the cecum and transverse colon.

B. Retrocecal ulcerated appendix. The barium collections correspond to ulcer craters verified at autopsy.

C

from vitamin deficiency. Nevertheless, the associated ileocecal disease and the more intense reaction, as well as the constancy of some of the patterns, speak for small intestinal tuberculosis.

*Appearance of Psoas Shadows:* The right psoas shadow may be obliterated or very poorly visualized as compared to that on the left (Fig. 3, D). The explanation for this phenomenon is not certain. Several factors appear to contribute to it. A combination of local disease with tumefaction or regional lymphadenopathy plays an important part. The not infrequent association of amyloid disease results in an enlargement of the liver with downward displacement of the kidney over the psoas shadow.

*Associated Liver and Spleen Enlargement:* A surprising number of patients have an associated amyloid disease. The enlarged liver and spleen may frequently be

Fig. 7. Case 7: C. Multiple girdling ulcers in the right and central portions of the transverse colon.

seen on the same film that demonstrates the ileocecal region. The other common cause for enlargement of these organs is a hematogenous tuberculous spread. In any case, an enlarged liver and spleen may be of indirect aid in the differential diagnosis. Enlargement of the liver alone may be confusing, since this might be due to metastases originating from a carcinoma of the cecum.

*Disturbances of Intestinal Motility:* Intestinal tuberculosis is usually associated with intestinal hypermotility. Barium may reach the cecum within one hour after oral ingestion. Hypermotility, however, is not invariable. In one patient barium did not appear in the cecum until the tenth hour.

#### DISCUSSION

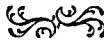
The presence of active pulmonary tuberculosis in our patients simplified the diag-

nostic problem. The diagnosis was confirmed at autopsy in 4 of the 7 cases. In the other 3 the clinical and roentgen evidence was so direct as to allow little question. Roentgen appearance of these cases is sufficiently constant to permit an accurate diagnosis. In a general hospital the differential diagnosis would admittedly be more of a problem. Certain differentiation from a non-specific terminal ileitis would be extremely difficult. Nevertheless, in the presence of active tuberculosis elsewhere, and with scrutiny of all the direct and indirect roentgen signs, some attempt at differentiation might be justified.

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# A Simple Method for Cardiac Measurements<sup>1</sup>

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THE MEASUREMENTS of the heart may be determined by the aid either of teleroentgenography or orthodiagraphy. The extensive use of teleroentgenograms for daily routine work, however, is beset with difficulties in private practice as well as in institutions because of lack of the necessary personnel and equipment. A major obstacle encountered in orthodiagraphy lies in the construction of the fluoroscope itself. In orthodiagraphy it is necessary to move the tube while the screen is held fixed over the patient's chest. Many fluoroscopes are not equipped with a detachable screen, the tube and screen moving together as a rigid unit.

Simple fluoroscopy, therefore, is often used to acquire information as to the size of the heart. The observer, in this instance, has to rely upon his personal impression, which is based upon his own experience. As no exact measurements are taken and no figures can be given, there is a very definite personal equation in this procedure.

It is felt that many would welcome a simple method that permits the taking of correct measurements of the heart in the course of fluoroscopy, thus substituting figures for impression. The following considerations, which comprise the basic principle of orthodiagraphy, aided in the conception of such a method, using the ordinary type of fluoroscope.

It must be assumed that the plane in which the tube moves, the diameter of the heart to be measured, and the screen are all parallel. If the tube is permitted to send only a small bundle of rays through a tiny opening in the shutter in front of it, these rays produce a small lighted area on the screen. If the tube is brought into the right position, a small part of the border of the heart shadow will be visible in the

center of this lighted area. Let us suppose that the screen is held fixed in one position over the patient's chest and the exact spot indicating one border of the heart shadow is marked on the screen with a pencil; if the tube is then moved until the opposite border of the heart shadow is visible in the lighted area and this spot is marked on the screen, as before, the distance between the two points on the screen must equal the distance between the borders of the heart. Obviously, however, it is of no advantage to indicate these points on a screen which moves with the tube.

In order to apply this principle to the ordinary type of fluoroscope in which tube and screen form a rigid unit, the following method was devised. The patient holds in front of the chest a wooden rod graduated by means of lead rings encircling it. The distance between each two rings is 1 cm. For rapid orientation the center ring is made wider, the others are marked with lead numbers. The wider central ring is held over the middle of the sternum. With a small opening in the shutter, one focuses upon the point of the heart shadow farthest to the right. This point is visible between two lead marks of the rod or may coincide with a mark. The maximum distance of the right silhouette border from the mid-sternal line can be noted. The tube is then moved until the point of the heart shadow farthest to the left is in the center of the small lighted area. Again the distance from the midsternal line is read on the rod. The transverse diameter of the heart is the sum of these two distances.

The main difference between the procedure described here and orthodiagraphy itself consists in the fact that in the present method one reads the distances directly in centimeters during fluoroscopy (Fig. 1) instead of marking spots on a screen and

<sup>1</sup> From the Cardiac Service of the Hospital for Joint Diseases, New York. Accepted for publication in August 1944.

measuring the drawing later. In estimating the distance from the next mark on the rod, one will hardly make a mistake of more than 2 mm.

Obviously, it is extremely important that the rod be held strictly parallel to the plane in which the tube moves as well as to the screen. All distances would be distorted, and the results of the measurements would be incorrect, if the rod formed an angle to the plane in which the tube moves.

With this method one is able to measure the greatest distances both to the right and to the left of the mid-line, the transverse, the broad, and the long diameter of the heart. If the graduated rod is attached to a suitable base standing on the floor, one is independent of the co-operation of the patient. Then not only is the right position of the rod easily maintained, but it becomes possible, also, to take measurements in the oblique position.

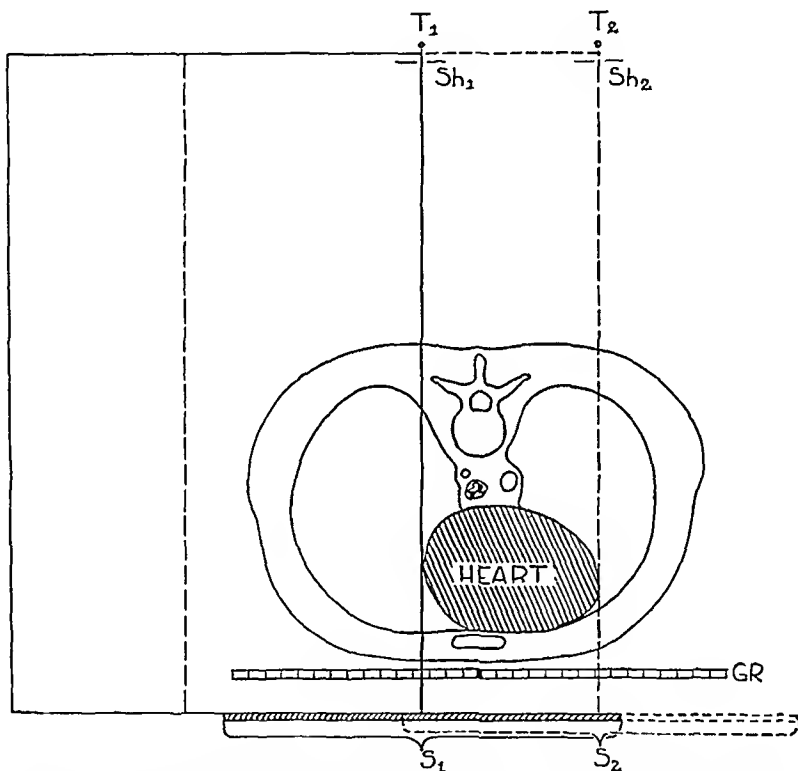


Fig. 1. Simple method of cardiac measurement.  $T_1$  and  $T_2$ . X-ray tube in two different positions.  $Sh_1$  and  $Sh_2$ . Shutter. GR. Graduated rod.  $S_1$ - $S_2$ . Screen.

The position of the rod can be controlled by concentrating upon the lead marks. If one examines one mark after the other, moving the tube along the rod with a small opening in the shutter, all marks appear as lines if the rod is in the right position. Should the rod be in an incorrect position, the lead marks will be seen as circles. As the lead marks are more distinctly seen over the lung fields than over the heart shadow, it is recommended that they be counted, if necessary, from the end toward the center.

The idea of using a graduated scale for taking measurements of the body during fluoroscopy is older than orthodiagraphy itself. A year before orthodiagraphy was introduced into medicine, Donath (1899) suggested a device for measuring the distances between two bones in the body. He fixed a graduated scale in front of the tube. A metallic indicator was then connected with the tube, gliding with it over the scale. While taking the measurements, the tube was moved until the indicator corresponded with the margin of the first bone. Upon

changing to ordinary light, it was necessary to look at the scale in order to note the position of the indicator. With the light given off by the x-rays the margin of the second bone was determined as described above.

Apart from the fact that it now appears impracticable to attach a scale to the tube and inspect it at variable intervals during an examination, as well as the inconvenience of changing from x-ray light to ordinary light several times during fluoroscopy, this older method permitted only the measurements of horizontal distances. All these disadvantages can be overcome by the use of lead markings on an otherwise transparent rod which can be fixed, within easy reach for adjustment, between patient and screen. The readings are made immediately during fluoroscopy without any appreciable loss of time. In point of accuracy the readings appear to equal the results obtained with orthodiagraphy. The necessary aptitude in taking the measurements is easily acquired.

It is hoped that this simple device will be found to be a workable supplement to fluoroscopy of the heart, yielding more exact data concerning its diameters. It may prove to be desirable in daily routine work in clinics and offices for the recording of findings or as a means of comparing the findings of different observers or the findings in a given patient at varying intervals. These measurements may also have a didactic value not only for beginners who wish to compare their findings with accepted values, but also for more experienced workers who feel that they wish to control their impression in borderline cases and acquire more objective data.

NOTE: The author wishes to express his gratitude to Dr. V. de Beck for valuable assistance in writing this paper.

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# Pes Planus: A Method of Mensuration<sup>1</sup>

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THE USE of roentgenograms for the detection of pes planus constitutes a simple, rapid, and precise method for the determination of the flatness of the longitudinal arch and the various degrees thereof.

Roentgenograms are taken with the foot in the lateral position, its external aspect against the film, and the x-ray beam directed from the inner to the outer aspect.

A tracing is made from the processed roentgenogram. It is not necessary, however, to trace the whole foot but rather to determine three points. To obtain these, a base line is drawn connecting the plantar surface of the head of the first metatarsal with that of the os calcis (Diagram 1). *A*

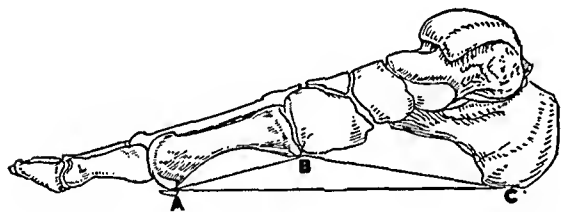


Diagram 1.

is the point of contact of the head of the first metatarsal with the base line, while *C* is the point of contact of the os calcis with the same line. *B* is the plantar surface of the base of the first metatarsal bone.

In patients whose feet are not absolutely flat, these three points will not be on a straight line. Euclidian plane geometry has taught us that through three points not lying on a straight line, one and only one circle can pass (1). To determine the radius of the circle passing through these three points, a line is drawn from *A* to *B*, and from *B* to *C*. Perpendicular bisectors to these lines are then constructed. The point of intersection of these perpendicular bisectors is the center of the circle passing

through the three points, *A*, *B*, and *C* (Diagram 2).

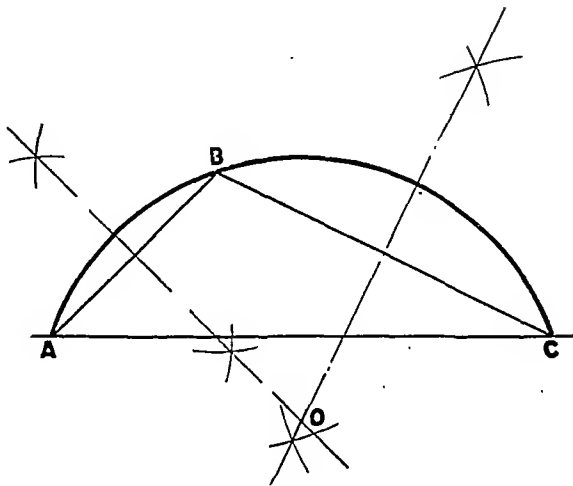


Diagram 2.

The distances *AO* (the radius of the circle) and *AC* (the chord) are then measured. The ratio *AO/AC* indicates the degree of flatness.

Ratio <i>AO/AC</i>	Interpretation
Up to 0.55 .....	Pes cavus
0.56-0.80 .....	Normal arch
0.81-0.90 .....	1st degree pes planus
0.91-1.0 .....	2nd degree pes planus
Greater than 1.0 .....	3rd degree pes planus

The above numerical values were derived from the construction of theoretical arches and their mensuration. These values were verified with roentgenograms of actual cases.

These figures are confirmed on the basis of mathematical principles. The flatter the arch or arc *ABC*, the larger the radius of the circle passing through these points until an arc is reached where the points *ABC* are lying on a straight line and the radius of the circle is infinitely large.

The chord *AC* connecting the head of the first metatarsal with the plantar surface of the os calcis, varies linearly and directly with the size of the foot. The length of the

<sup>1</sup> Accepted for publication in June 1944.

radius is proportionate linearly and inversely to the degree of curvature of the arch. (The curvature of the circle equals the reciprocal of the radius. Granville, 2.) The ratio of the radius  $AO$  to the chord  $AC$ , as pointed out above, will produce a referable number by means of which various degrees of flatness of the longitudinal arch may be compared.

The points  $A$ ,  $B$ , and  $C$  have been chosen because they are on the longitudinal arch. They are easily seen and constant on every film of the foot. With progression of the degree of flatness of the arch and changes

in the size of the foot, these points too will vary.

The ratio  $AO$  to  $AC$  in a given foot remains constant even when roentgenograms are taken in positions varying from a true lateral to an oblique.

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# Comparison of Physical and Biological Methods of Depth Dose Measurement<sup>1</sup>

CHARLES PACKARD, Ph.D.,<sup>2</sup> and FRANK M. EXNER, M.A.<sup>3</sup>

MANY radiologists have attempted to measure surface and depth doses under the actual conditions which they meet in practice, but the results have often been unsatisfactory because these measurements are difficult to make properly without special equipment and experience. That they are difficult even under the best conditions is shown by the considerable amount of disagreement in the data of qualified observers.

In view of this situation, it is now often recommended that the radiotherapist measure only free air doses and from these measurements calculate the desired tissue doses with the help of published ratios of surface and depth doses to air doses. The lack of complete and reliable compilations of such ratios, however, has been a handicap in following this procedure. To help fill this need it seemed to us desirable to make a comprehensive series of measurements of surface and depth dose ratios covering the whole range of deep therapy conditions. It was clearly essential, first, to make a thorough study of the possible reasons for the discrepancies between the results of previous observers, and to develop equipment and methods giving the greatest possible control over all the variables in the depth dose problem. A generator specially built for this purpose is described in the following paper, where a complete description of the beams of radiation used in the present experiments will also be found.

The task just outlined was undertaken as a long-term project about 1932 and was finished in 1942. Preparation of the results for publication, in this and the following paper, has been delayed by extraneous circumstances.

While the published measurements of tissue doses have been discordant, it is obvious that the distribution of any particular beam in a particular phantom is a definite and reproducible phenomenon. The discrepancies found in the literature of this subject are presumably due to (1) inadequate specification of the beam of radiation used; (2) use of different phantom materials and dimensions; (3) use of different dosimeters.

The present paper deals with the last of these points, namely, the selection of an appropriate measuring instrument for obtaining surface and depth dose ratios of reliable clinical significance.

In the past, both physical and biological methods have been used in making such measurements. Each method has its advantages and disadvantages. Ionization chambers permit rapid and precise measurements to be made. Such measurements, however, are subject to uncertainties connected with the geometrical characteristics and wave-length dependence of the chamber used. A biological test material, on the other hand, indicates dosage directly in terms of a biological effect. It has the further advantage that the disturbing effect of introducing an air cavity into the phantom may be avoided. But the method is laborious and, in comparison with physical measurements, is lacking in precision.

In the present paper, measurements by both methods are compared for radiations produced at approximately 200, 500, and 1,000 kv. No significant differences have been found between the *ratios* of tissue to air dose as given by the two methods. The ionization method was then employed to obtain an extensive series

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of surface and depth dose ratios covering the entire range of deep therapy conditions. The paper which follows this one describes these measurements together with an investigation of the conditions which should be fulfilled in order to obtain results which can be reproduced in another laboratory.

#### NOMENCLATURE

We shall follow the definitions of radiological terms given in the Glossary of Technical Bulletin No. 1 of the Radiological Society of North America (1). In this list the ratio of depth to skin dose is designated by the familiar term, percentage depth dose. *There seem, however, to be no accepted terms for two other important ratios: the ratio of depth dose to free air dose and the ratio of skin dose to free air dose.*

Instead of giving names to these ratios, we shall use the symbols  $D$ ,  $D_0$ , and  $D_n$  for free air dose, skin dose, and depth dose (or intensity), respectively, as proposed by the Fifth International Congress of Radiology. We propose to represent the ratios by writing them explicitly  $D_0/D$ ,  $D_n/D$ , and  $D_n/D_0$ , to be read as "surface to air ratio," etc.  $D_n/D_0$ , or depth to surface ratio, will be recognized as the familiar "percentage depth dose."

We shall express all dosage ratios as percentages, in conformity with established usage in the case of "percentage depth dose."

The practice of expressing dosage ratios in percentages leads to an ambiguity in speaking of errors or differences in these ratios. For example, if two  $D_n/D_0$  are given as 20 per cent and 21 per cent, their absolute difference is 1 per cent, while their fractional difference is one part in twenty, or 5 per cent. *In the present paper, differences between ratios will be expressed in fractional form; 20.2 per cent will be said to depart from 20.0 per cent by a fractional difference of 1 per cent.*

The following abbreviations and symbols will be used:

- f.s.d.: Focal skin distance  
h.v.l.: Half-value layer

- $h$ : Homogeneity coefficient = ratio of second to first h.v.l.  
 $D$ : Free air dose or intensity  
 $D_0$ : Surface dose or intensity (at depth of 0 cm.)  
 $D_n$ : Depth dose or intensity (at depth of  $n$  cm.)  
 $D_e$ : Exit dose or intensity

#### METHOD OF MEASUREMENT

(A) *Physical*: The ionization chamber employed throughout this experiment was the widely used Victoreen condenser dosimeter, with a "25-r" chamber. *To assure electron equilibrium, caps of organic material up to 2 mm. thick were placed over the chamber during all free air and surface measurements at voltages above 300 kv. The chamber and the method of submerging it in the water phantom are described in the following paper.*

For voltages up to 200 kv. the dosimeter is calibrated in roentgens by the manufacturer, by a procedure approved by the National Bureau of Standards. To check the calibration, the instrument we used was returned to the factory at intervals. Between checks, three different chambers belonging to the electrometer were frequently intercompared. Comparisons were also made with other recently calibrated dosimeters. Over a period of years the calibrations of our three chambers (one 100 r and two 25 r) have remained constant within less than 1 per cent. Their relative indications, however, show differences up to 1 or 2 per cent, depending on the quality of radiation over the range up to 1,000 kv.

Readings were always corrected for temperature and pressure, the water in the phantom being kept at room temperature. For observations of surface intensity, the chamber was placed in the half submerged position.

(B) *Biological*: In the biological method, the dose to be measured is estimated from some clear quantitative reaction which follows exposure.

Of the many test objects used for biological measurement of x-rays, the eggs of

*Drosophila* have proved the most useful, because, unlike most other living material, their sensitivity can be kept remarkably constant year after year. This characteristic is not confined to a single stock of wild flies but is found in many stocks both in this country and abroad. Thus, in this laboratory, where the temperature has been constant at 20–22° C., a dose of 190 r kills, on the average, half the eggs in a sample. The same response is reported by Jüngling and Langendorff (3), who used the same technic as ours.

Data illustrating this constancy of response have already been published (4). From these and similar data collected over a period of years, a curve has been constructed showing the relation between roentgen doses and the survival rate of the eggs over a wide range of dosage (5). The slope and position of the survival curve plotted from data taken at 120 kv. are the same as the curves obtained in experiments with voltages ranging from 10 to 200 kv. (6, 7). Thus, this standard curve can be used not only to predict the survival rate which will follow any dose of radiation within these limits of voltage but, conversely, to determine from the survival rate what dose has been given. The validity of this method of measurement has been examined statistically (5) and the conclusion drawn that the roentgen dose estimated from the survival rate could be predicted (in the series examined) with a precision of the order of one part per hundred when the survival rate was about 50 per cent, and of the order of two parts per hundred when the survival rate was about 20 or 80 per cent.

This uniformity of response will not be found, however, if the temperature at which the eggs are prepared and exposed rises substantially above 20–22° C. This is shown in the following experiment. Eggs were collected from culture bottles incubated at 24–25° C. for two hours. They were then divided into two portions, one kept at 20° C. throughout the hour when they were being prepared for exposure, and the other at 27° C. In the ex-

TABLE I

Eggs Prepared at 20° C.			Eggs Prepared at 25° C.		
Dose in r	Per cent Alive	Per cent Expected	Dose in r	Per cent Alive	Per cent Expected
133	71.4	72.7	177	76.1	54.7
177	57.5	54.7	184	71.8	52.2
184	53.6	52.2	222	59.5	39.5

posure room, where they remained for about fifteen minutes, the temperature was 20° C. The data in Table I show the marked difference in the response of the two portions. The doses, measured by the dosimeter, are given in the first column; in the second appear the actual survival rates, and in the third, the expected rate according to the standard curve. It appears that when the eggs are kept cool, especially during the hour of preparation before exposure, their reaction does not differ significantly from that observed in previous tests under these conditions; but when the temperature is high during this period, the eggs undergo more cell divisions than do the others and are correspondingly less sensitive. In these tests their sensitivity was only 73 per cent of that shown by the sample kept at the lower temperature. In this instance, the 50 per cent survival dose is 260 r instead of 190 r. Sievert and Forssberg (8) report that in their experiments the half killing dose was 165 r, while den Hoed (10) found that under certain conditions it was 150 r and at another time 300 r. Evidently, then, those who use these eggs to measure dosage should maintain constant temperature conditions throughout all their experiments in order that their results may be consistent with each other. Even if this is not possible, measurements of surface and depth dose ratios, or ratios between the reaction of eggs in air and under some other condition, can still be carried out provided the exposures are made simultaneously, inasmuch as the ratios are not affected by changes in the sensitivity of the eggs.

In recent experiments a disturbing factor not previously observed, has been the occasional aberrant behavior of eggs obtained

from perhaps a single culture bottle out of the six or eight usually employed in a test. Such eggs are far less sensitive than the rest, although they have been collected in the same way as the others. To correct this difficulty, the following procedure has been used in all recent experiments. The

air, a third is irradiated at the surface of the phantom, and a fourth at some distance below the surface. Subsequently, the survival rates in each sample are obtained and the surface and depth dose ratios calculated independently for each culture bottle by a method to be described

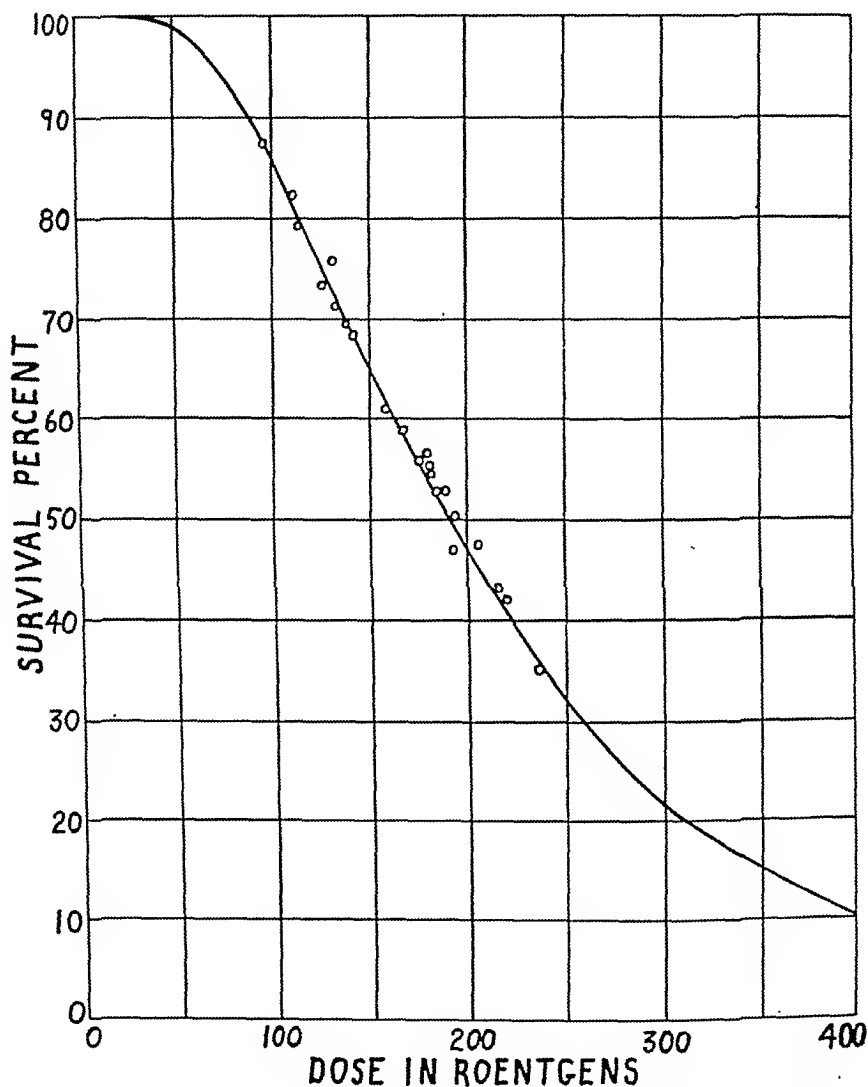


Fig. 1. Roentgen-ray survival curve for *Drosophila* eggs kept at 20°–22° C. before exposure.

The curve represents a large amount of previously published data for Cu h.v.l. 0.33 mm. (120 kv., 0.25 mm. Cu filter). New observations at Cu. h.v.l. 1.35 mm. are shown by the circles.

eggs obtained from each culture bottle are divided into approximately equal portions, which are placed on several pieces of black filter paper cut into some distinctive shape. In this way the records of the eggs from each bottle can be kept separate from all the others. One portion serves as a control, another is exposed in

later. Although the absolute survival rates may at times differ among themselves considerably, the dosage ratios deduced from them agree very well.

The procedure for obtaining the amount of exposure from the survival rate must now be further explained. It has been stated that the dose which the eggs have

received can be determined by finding on the curve (Fig. 1) the number of roentgens corresponding to the observed survival rate. At voltages below 200 kv., these doses will be expressed in standard roentgens. For example, a 50 per cent survival indicates a dose of 190 roentgens.

*It is convenient to say that for radiations of any higher voltage, the dose which produces 50 per cent survival in the sample is 190 units, even though the dosimeter indicates a different number.* These units have been called "biological roentgens," or "equivalent roentgens," convenient terms for expressing in biological units the amount of exposure directly in terms of biological effect. But these terms are open to objection. Instead, we shall use the term *Drosophila* unit.

After much preliminary work, the measurements to be reported in this paper were begun in 1936 and were continued, with many interruptions up to 1942. During this time each experimental condition, involving half-value layer, area, surface, and depth, was repeatedly tested. The figures given in the tables are averages of all tests made under the conditions mentioned. It is a matter of interest that the first and last measurements—separated by a space of nearly six years—of the surface to air ratio at a voltage of 900 kv. and 100 cm. area gave results which differed from each other by less than 1 per cent.

In all, upward of 500 separate experiments have been made, the average number of eggs in each being 1,200. Thus, well over half a million eggs have been exposed and counted in addition to the controls. In the latter, the hatching rate averaged 95 per cent, a somewhat lower value than that obtained in previous experiments.

#### COMPARISON OF BIOLOGICAL AND PHYSICAL MEASUREMENTS

(A) *Wave-length Effects:* In the preceding section it was stated that the *Drosophila* unit was found to be equivalent to the standard roentgen over a volt-

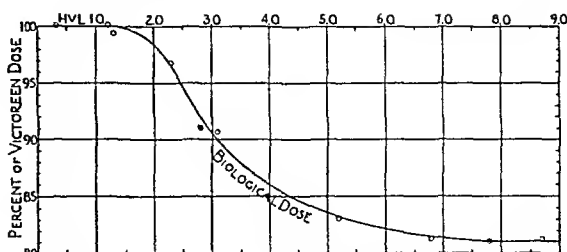


Fig. 2. Curve showing the effectiveness, in killing *Drosophila* eggs, of equal doses of roentgen rays as measured by a Victoreen dosimeter.

The effectiveness of doses of 100 Victoreen units is plotted against Cu h.v.l. (mm.).

age range from 10 to 200 kv. The question whether this parallelism continues to higher voltages is complicated by the fact that the measurement of such radiations in roentgens has not been satisfactorily realized. In this situation it is convenient to use the indication of the Victoreen instrument as an arbitrary basis of dosage, expressing the readings in "Victoreen units."

A preliminary report on the relation between the Victoreen and the *Drosophila* units has been published (9). The results of a fuller study of this relation are shown in Figure 2. The falling curve indicates that the ratio of the *Drosophila* to the Victoreen dose rapidly diminishes between the half value of 2 to 5 mm. of copper, and for higher half values diminishes but little. Expressed in another way, the harder radiations when measured in Victoreen units appear less effective than the softer radiations.

Den Hoed (10) came to the same conclusion, finding that for equal doses measured by a Siemens dosimeter, the effectiveness of a beam of h.v.l. 5.9 mm. copper in killing *Drosophila* eggs is about 75 per cent of what it is when the beam has a h.v.l. of 1 mm. Evidence suggesting that this relation is not peculiar to *Drosophila*, but may be found elsewhere, appears in Stone's observation (12) that to give equal erythemas, the skin dose, including scatter, of 1,000-kv. radiation as measured by the Victoreen must be increased over that of 200-kv. radiation by about 25 per cent. This relation, however, is not universal. Special types of test material such as



TABLE II: TO ILLUSTRATE THE METHOD OF CALCULATING SURFACE/AIR AND DEPTH/SURFACE RATIOS, AND THE AMOUNT OF VARIATION IN SENSITIVITY IN SAMPLES OF EGGS DERIVED FROM DIFFERENT BOTTLES EXPOSED AT THE SAME TIME

(Copper h.v.l. 5.2 mm.; area 100 cm.<sup>2</sup>; f.s.d. 70.7 cm. Intensity measured in Victoreen units/min.)

Air Dose, 9 min.		Surface Dose, 9 min.			10-cm. Depth Dose, 18 min.		
Per cent Alive	Drosophila Units	Per cent Alive	Drosophila Units	D <sub>0</sub> /D	Per cent Alive	Drosophila Units	D <sub>n</sub> /D <sub>0</sub>
37.1	230	29.2	263	114.3	32.7	247	46.7
59.1	166	49.3	192	115.7	53.0	182	47.8

those in which x-ray-induced gene mutations may be observed, show a very different relation between h.v.l. and dose (11).

(B) *Geometrical Effects*: Some of the geometrical complications inherent in the application of thimble chambers to the measurement of surface to air ratios have been discussed by Quimby, Marinelli, and Farrow (18). The ratio of depth (chamber fully submerged) to surface (chamber half submerged) doses involves additional geometrical complications. As is stated by these authors, it is difficult to evaluate the importance of all these possible sources of error, which may be too small to be significant or may tend to cancel out. To test the validity of ratios measured with a thimble chamber, it is best to compare them with values obtained by some other method which avoids these errors without introducing new ones.

The small size of *Drosophila* eggs ( $0.2 \times 0.5$  mm.) makes it possible to avoid these geometrical errors. It is true that during depth exposures the eggs are kept in a bakelite holder (see following section) which has an air cavity 3 mm. in thickness, a condition which might have a disturbing effect. To test this point, eggs were exposed in a gelatine jelly container with a cavity just deep enough to hold them. To avoid possible damage to the eggs from lack of oxygen, they were ventilated by a stream of air introduced through a rubber tube about 1 mm. in diameter. The results of depth measurements with this container agreed with those made with the bakelite holder. The test was made with a beam having a copper h.v.l. of 0.3 mm. We conclude, therefore, that the air cavity had no disturbing effect.

This test was made before our high-voltage equipment was set up and was not repeated with hard radiation.

#### PHANTOM MEASUREMENTS TECHNIC

A description of the water phantom is given in the following paper. Free air and surface measurements were made at a focal distance of 70.7 cm. *At higher voltages both eggs and chamber were covered with sufficient organic material to ensure secondary electron equilibrium.* The thimble chamber, protected by a close-fitting thin rubber cover, could be placed at any desired position in the phantom. The beams of radiation were filtered and diaphragmed in such a way as to contain a minimum of secondary x-rays. The physical measurement and specification of the beams used are described in full in the following paper.

A typical biological experiment is performed in the following way. Several thousand eggs are collected from culture bottles incubated for two hours at about 25° C. During the next hour the eggs are prepared for exposure by transferring about 200 of them, by means of a camel's-hair brush, to each of a number of slips of filter paper about  $1.5 \times 1.5$  cm. in size. As mentioned before, the eggs from each culture bottle are placed on slips cut into some distinctive shape so that when they are counted the results can be calculated separately.

The eggs are usually exposed in three positions simultaneously, that is, in air without scatter, at the surface, and at a depth in the phantom. This procedure is made possible because the generator at our disposal has several ports. The samples irradiated in air are placed on a sheet

TABLE III: SURFACE/AIR RATIOS DETERMINED BY THE BIOLOGICAL METHOD WITH PHYSICAL VALUES FOR COMPARISON

h.v.l. mm. Cu	10 cm. <sup>2</sup>		50 cm. <sup>2</sup>		100 cm. <sup>2</sup>		200 cm. <sup>2</sup>		400 cm. <sup>2</sup>	
	Biological	Physical	Biological	Physical	Biological	Physical	Biological	Physical	Biological	Physical
1.35	114.6 ± 0.44	112.0	125.7 ± 0.83	124.0	132.5 ± 0.71	132.0	...	...	143.2 ± 0.72	144.1
5.2	107.2 ± 0.14	106.8	115.0 ± 0.31	113.2	116.1 ± 0.42	117.7	120.2 ± 0.21	121.5	123.6 ± 0.99	124.5
6.9	...	...	...	...	112.4	112.5	...	...	...	...
8.7	103.8 ± 0.43	104.0	106.3 ± 0.45	105.9	107.1 ± 0.45	107.7	...	...	111.2 ± 0.44	112.2

TABLE IV: DEPTH/SURFACE RATIOS DETERMINED BY THE BIOLOGICAL METHOD

Area →	10 cm. <sup>2</sup>	50 cm. <sup>2</sup>	100 cm. <sup>2</sup>	200 cm. <sup>2</sup>	400 cm. <sup>2</sup>
Copper h.v.l. 1.35 mm.; f.s.d. 70 cm.					
Depth, cm.					
1	...	...	...	...	99.8 ± 0.68
5	...	...	66.4 ± 0.82	...	77.3 ± 0.49
10	21.5 ± 0.48	29.1 ± 0.63	35.8 ± 0.52	...	46.0 ± 0.66
Copper h.v.l. 5.2 mm.; f.s.d. 70 cm.					
1	...	...	98.9 ± 0.81	...	...
3	...	...	86.0 ± 0.53	...	...
5	...	65.1 ± 0.38	69.3 ± 0.59	74.3 ± 1.47	77.0 ± 0.52
10	26.3 ± 0.51	35.6 ± 0.25	41.0 ± 0.36	45.0 ± 0.33	50.5 ± 0.42
15	...	...	24.8 ± 0.61	...	...
20	...	...	12.4 ± 0.38	...	...
Copper h.v.l. 8.7 mm.; f.s.d. 70 cm.					
1	...	...	103.0	...	...
5	...	...	74.5	...	...
10	35.2 ± 1.59	42.1 ± 0.38	46.0 ± 0.63	...	52.7 ± 0.77
15	...	...	27.7 ± 0.72	...	...

of gauze held vertically in a wooden frame in front of one of the side ports. The phantom is placed below the bottom port. In making surface dose exposures, the slips carrying the eggs are supported on a raft made of varnished gauze or cellophane attached to a light wooden hoop. For voltages above 250 kv., the eggs exposed in air and at the surface are covered with sufficient celluloid for electron equilibrium. For exposures at a depth, the eggs are placed in a holder made of a sheet of bakelite 0.3 mm. in thickness, in which square holes about 2 cm. on a side have been cut. These are sealed on the under side with cellophane and beeswax. The slips of paper with their eggs are then placed in these compartments, which are slightly moistened so that the slips will stick to the bottom. A second sheet of cellophane is sealed over them, making water-tight compartments in which the eggs can stay several hours without suffering from lack of oxygen. Actually they are seldom

sealed up for more than thirty minutes.

When the holder is placed in the water phantom, it is inverted so that the eggs lie next to its upper surface, from which the depth is measured. It is held accurately in place at the desired depth by cleats fastened to the walls of the phantom. Before each exposure the depth of the eggs below the surface is carefully checked, and the phantom is accurately centered under the bottom port of the generator. The phantom and holder are shown in Figure 4 of the following paper.

The beam is so adjusted that at the greatest depth the intensity will be well above 5 r/min. Before each irradiation the equality of intensity at the side and bottom port positions is tested with the ionization chamber. Often two or even three depth exposures are made at the same time, together with the surface dose measurement. The exposure for all of the eggs thus arranged begins at the same time and is interrupted, after an appropriate length of

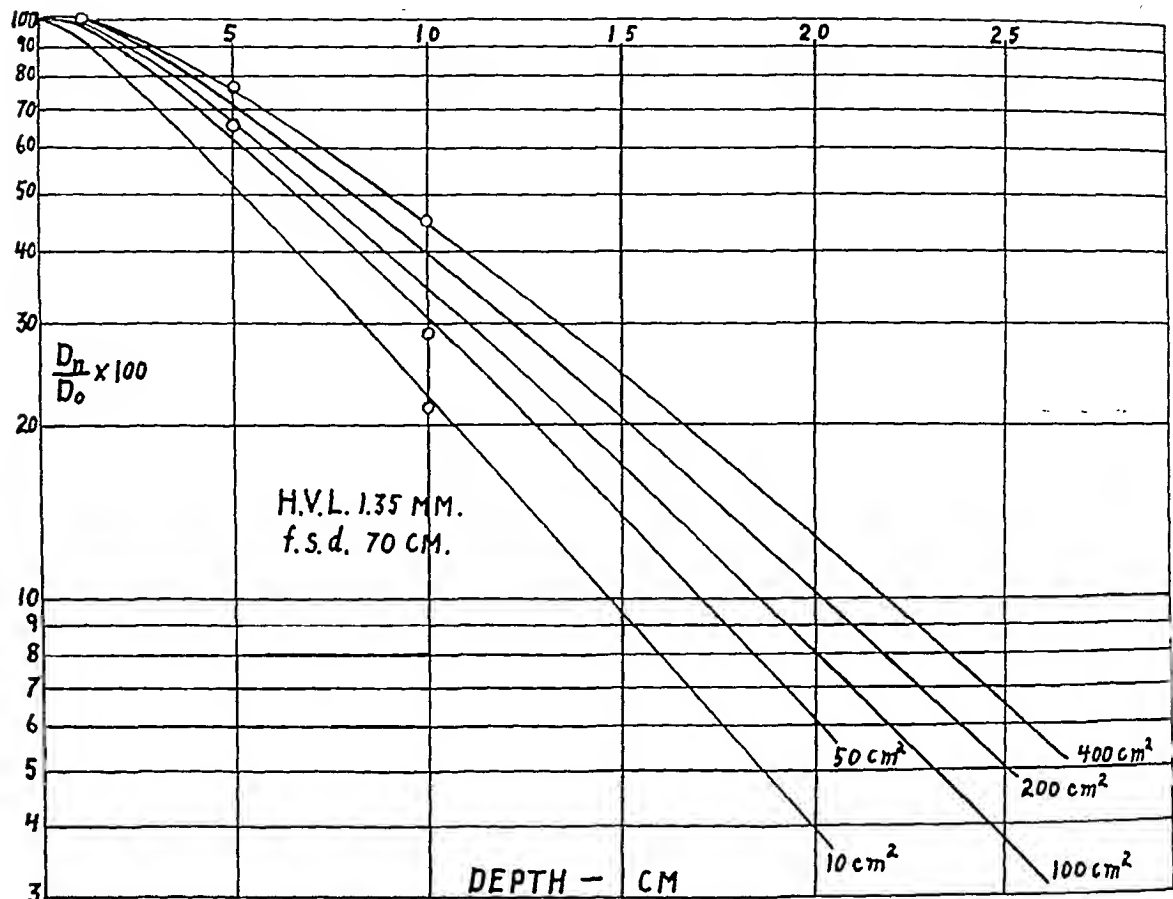


Fig. 3. Comparison of depth to surface ratios (percentage depth doses) measured with *Drosophila* eggs and with a Victoreen dosimeter. H.v.l. 1.35 mm., f.s.d. 70 cm. The curves represent Victoreen measurements described in the following paper. The *Drosophila* measurements are shown by circles.

exposure, long enough to remove the samples at the surface and in air. Irradiation is then resumed for the eggs at the depths and is continued until all have received the desired dose.

The doses, measured in *Drosophila* units, at these various positions are calculated from the survival rates, and from these the  $D_0/D$  and  $D_n/D_0$  ratios are calculated. As mentioned before, these measurements are calculated separately for the eggs derived from each culture bottle, so that variations in sensitiveness do not affect the ratios.

The method of making these calculations is illustrated in Table II, which includes, also, an example of the fact that occasional changes in the sensitiveness of eggs from a single bottle do not affect the ratios. The horizontal series of figures are measurements and calculations from individual culture bottles. In the first vertical column of each section are the

percentages of eggs surviving after exposure to the indicated dose of Victoreen roentgens. In the second column are given the number of *Drosophila* units corresponding to these percentages. The third column of sections 2 and 3 give the  $D_0/D$  and  $D_n/D_0$  ratios, respectively. It will be seen that, although the actual hatching rates and the number of corresponding *Drosophila* units in each column differ greatly, the ratios do not. Indeed, the agreement is excellent.

RESULTS

Most of the experiments were made with beams having half value layers of 1.35, 5.2, and 8.7 mm. of copper. The results are given in Tables III and IV. Each figure is an average of many separate tests made under similar experimental conditions, often separated by months or even years. The amount of variation between indi-

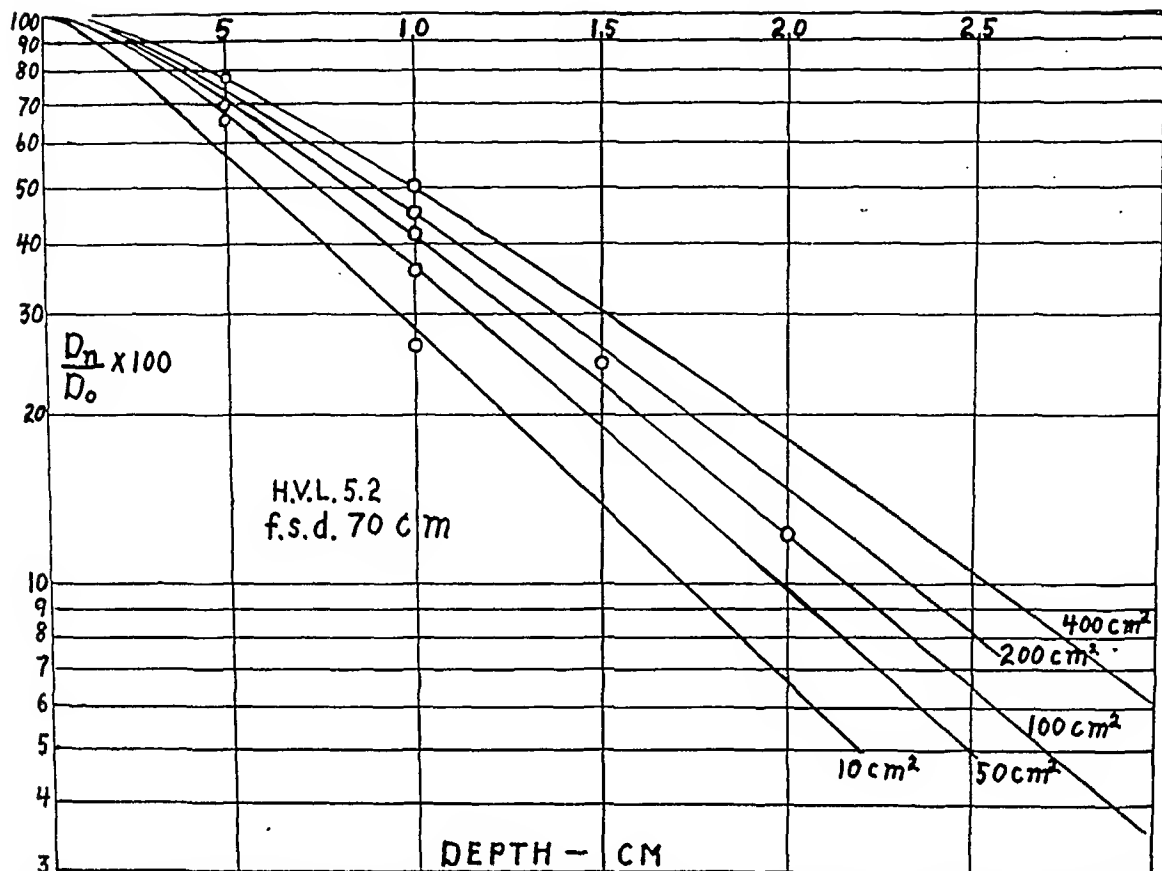


Fig. 4. Comparison of depth to surface ratios (percentage depth doses) measured with *Drosophila* eggs and with a Victoreen dosimeter. H.v.l. 5.2 mm., f.s.d. 70 cm.

The curves represent Victoreen measurements described in the following paper. The *Drosophila* measurements are shown by circles.

vidual tests may be inferred from the probable errors of the means, which are calculated for each. In addition, other observations were made at intermediate half values. All the  $D_n/D_0$  ratios are shown in Figures 3, 4, and 5, where they may be compared with the results of dosimeter measurements shown by the curves. The data for the latter are given in the subsequent paper. The differences between the  $D_0/D$  and  $D_n/D_0$  ratios obtained by the two methods are small and within the limits of experimental error. The conclusion is, therefore, that the biological and physical methods of measurement of phantom ratios give results which are in complete agreement.

#### DISCUSSION

An extensive series of biological measurements in which *Drosophila* eggs were

employed has been made by Langendorff, Graf, and Graf (13). With a beam having a half value of 0.95 they found  $D_n/D_0$  ratios, for areas of 50 and 400 sq. cm., to be definitely greater than those obtained with the dosimeter. Henshaw (2), on the other hand, who also used these eggs as test material, reports that under radiation produced at 165 and 650 kv. these ratios are lower than his dosimeter values.

The close correspondence which we find between the biological and dosimeter ratios is worthy of discussion, for, *a priori*, one might suppose that they should not agree. For example, when a beam having an h.v.l. of 5.0 mm. Cu is scattered in a phantom, one might imagine that its h.v.l. could be reduced to 3.0 mm. Cu. Its biological effectiveness, as compared with the free air beam, will thereby be increased by about 9 per cent, as shown

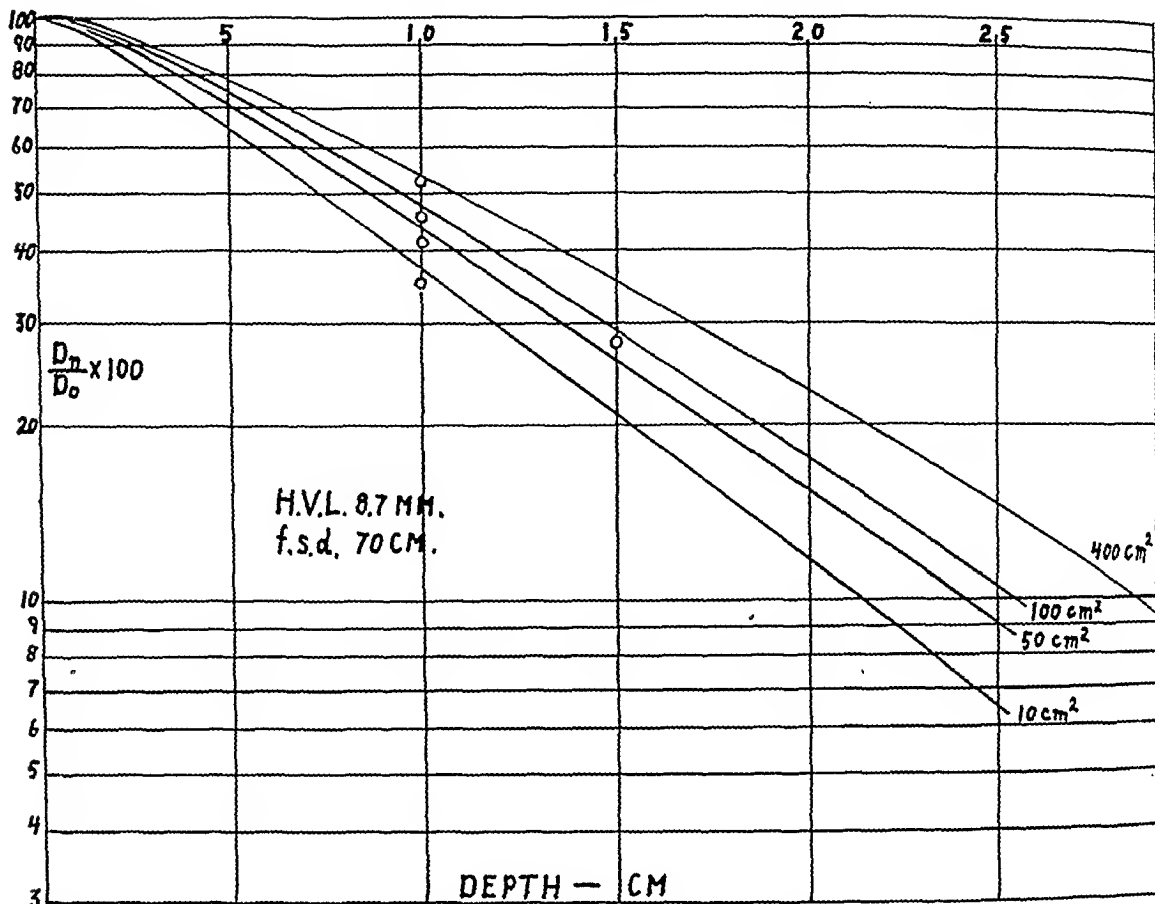


Fig. 5. Comparison of depth to surface ratios (percentage depth doses) measured with *Drosophila* eggs and with a Victoreen dosimeter. H.v.l. 8.7 mm., f.s.d. 70 cm.

The curves represent Victoreen measurements described in the following paper. The *Drosophila* measurements are shown by circles.

in Figure 2. The result of this would be that the  $D_n/D_0$  ratio would become greater than that shown by the dosimeter. That no such difference has been found may mean simply that the amount of softening due to scatter is too small to produce an effect which we can measure.

**ACKNOWLEDGMENTS:** We take pleasure in expressing our thanks to Professor Francis C. Wood, under whose direction these studies were begun, for his valuable suggestions and unfailing interest; and to the Markle Foundation for their generous support during a part of this investigation. To Dr. Henry Quastler and Miss Doris Meisel we are grateful for help in carrying out many of the experiments.

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# Measurements of Surface and Depth Dose

## Ratios from 70 to 1,000 Kv.<sup>1</sup>

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IN GIVING deep x-ray therapy it is necessary to determine the doses to which the skin and underlying tissues are exposed. Some of the steps to be taken when tissue doses must be determined accurately may be listed as follows:

1. Measure the free air dose at the point which is to be the center of the field on the skin.
2. From known ratios of tissue doses to the free air dose, for the conditions of the exposure, determine the doses at the center of the field for the entrance and exit skin surfaces, and for any desired depths.
3. Find the lateral distribution of tissue dose over the field at the tumor level. For this purpose, a suitable isodose chart may be used (1, 15), together with a knowledge of the lateral distribution of intensity in the primary beam.
4. From the size of the focal spot and the position of the defining diaphragm, find the width of the penumbra inside and outside the edge of the geometrical field at any important levels.
5. Allow for the effect of bone, gas, or fat in the exposed region.
6. If the ratio of length to width of field is greater than about 2, apply the proper correction (2).
7. In case of cross-fire, add the superposed doses.
8. For very hard radiations consider the possible effects of incomplete secondary electron equilibrium (3).
9. For excitation voltages above approximately 250 kv., take account of any available information on the biological efficiency of the unit in which the dosage is measured (such as a particular thimble chamber unit). (Preceding paper, and 4.)

The present paper is concerned with providing a comprehensive, reliable, and convenient set of dosage ratios to be used in the second step of the procedure just outlined.

In order that all deep therapy radiations, from the softest to the hardest, might be measured under similar experimental conditions, a special generator was built, and

much time was spent in working out methods for precisely controlling all the experimental conditions. A particular effort was made to select conditions for the measurements such that the results might be reproduced, if desired, by any other experienced observer in a well equipped laboratory.

Since the experiments were completed, their preparation for publication has been delayed by pressure of other duties. To avoid further delay, we are presenting our own results with almost no reference to earlier literature containing valuable discussions of questions dealt with in the present paper. Instead, two recent publications containing bibliographies and compilations of dosage ratios (5, 14) and a few still more recent reports of new measurements (6, 7, 16, 17) are cited.

*Methods were devised for presenting all depth dose ratios by means of a few unfamiliar but very simple charts, which permit interpolation for any set of exposure conditions. The way in which the charts are obtained is explained in detail; and at the end of the paper summarized directions for their use are given. These directions are accompanied by a numerical example and are intended to be self-explanatory, so that the charts can be used, if desired, without reference to the rest of the paper.*

The paper is divided into sections as follows:

- Part 1. Description of apparatus.
- Part 2. Analysis of conditions to which deep therapy beams should conform in order that depth dose measurements may be reproduced from one laboratory to another.
- Part 3. Specification of beams to be employed in the following depth dose experiments.

<sup>1</sup> From the Department of Cancer Research, College of Physicians and Surgeons, Columbia University, New York 32, N. Y. Accepted for publication in October 1944.

<sup>2</sup> Now at Minneapolis-Honeywell Regulator Co., Aero Division, Minneapolis, Minn.

<sup>3</sup> Now at The Marine Biological Laboratory, Woods Hole, Mass.

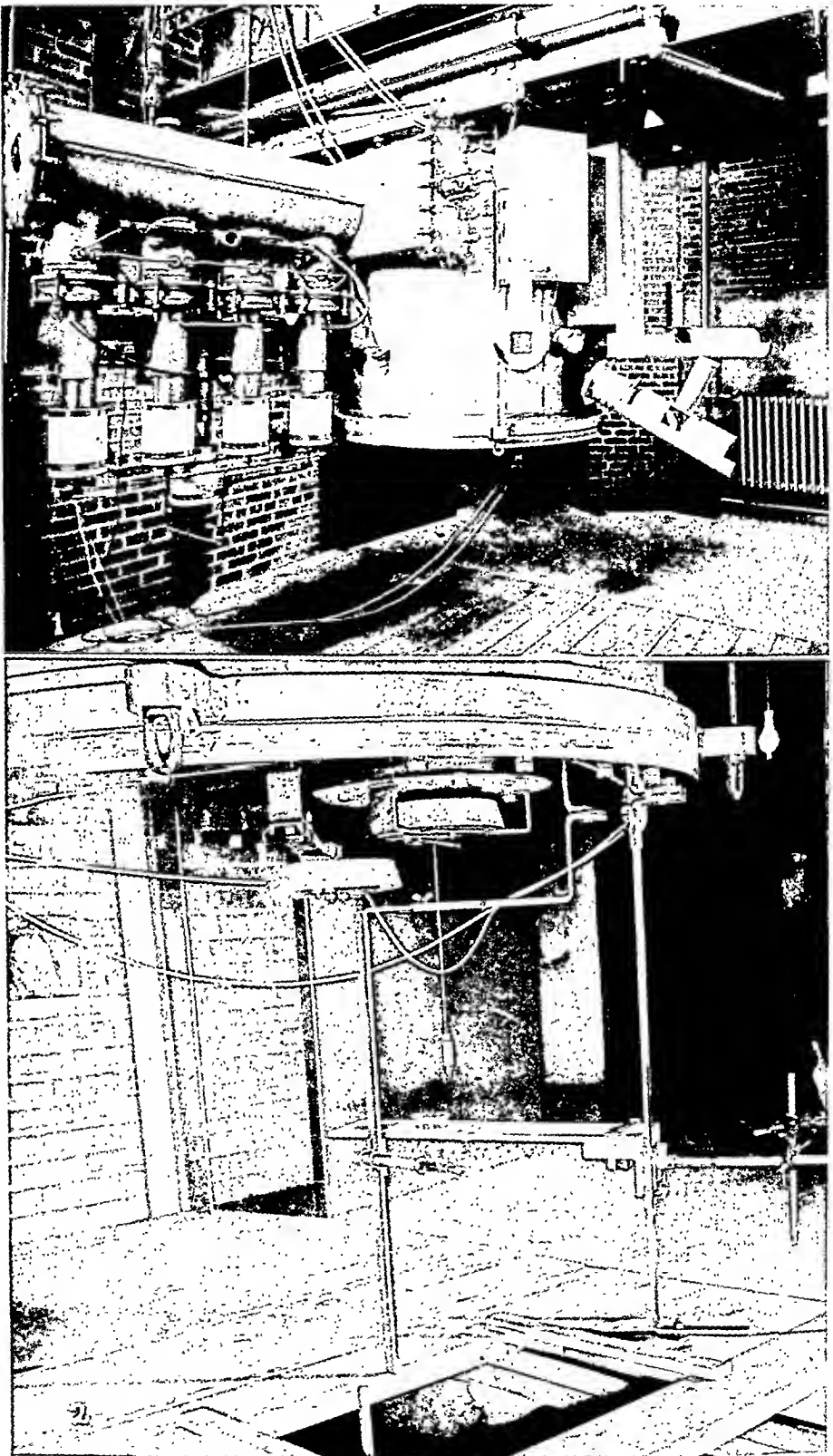


Fig. 1. Vacuum chamber of Sloan x-ray generator. Three of four side ports fitted for deep therapy can be seen at the right; vacuum pumps at the left. The sides of the vacuum tank are covered with 2 inches of lead, with 3 additional inches on the side toward the control room. In a copper shield above the vacuum chamber are mounted two continuously pumped oscillator tubes capable of supplying peaks of over 100 kilowatts at 6 megacycles to the primary of the resonance transformer in the vacuum chamber.

Fig. 2. Bottom port, showing diaphragm, shutter and arrangements for free air exposures.



Part 4. Measurement of surface and depth dose ratios in water, at center of field, for copper half-value layers from 0.1 to 8.7 mm.; surface areas 10 to 400 cm.<sup>2</sup>; depths from 0 to 30 cm.; focal skin distances 50, 70, and 140 cm. A few measurements in presdwood and meat are described for comparison with water. A few exit doses were measured.

Part 5. Representation of measured surface and depth ratios by graphical methods, permitting convenient interpolation. Simple method for calculating exit doses. *Summarized directions for using dosage charts.*

[As explained in the preceding paper, we represent free air, surface, depth and exit doses or intensities by the symbols  $D$ ,  $D_0$ ,  $D_n$ , and  $D_e$ , respectively.]

#### PART 1. DESCRIPTION OF APPARATUS

**A. Generator:** In order to study depth dose problems over the whole range of deep therapy conditions, it was desirable to have a generator capable of operating at voltages from about 70 to 1,000 kv. and having very small inherent filtration. The biological part of the work (see preceding paper) required large outputs at all voltages. It was necessary to have the output steady and reproducible, with instantaneous on-and-off control. A small focal spot, flexibility of diaphragming arrangements, and freedom from scattered radiation were also desired.

Such a generator of the Sloan (9) radio-frequency resonance transformer type was built for this purpose. In this apparatus a tungsten target hung at the free end of a water-cooled quarter-wave resonant coil in a metal vacuum chamber, shown in Figure 1. A biased filament emitted electrons to the target over a greater or less portion of the positive half cycle of target potential, depending on the amount of bias potential. Close control of emission was given by fine adjustment of bias. Cut-off bias applied by a double-throw switch provided instantaneous on-and-off control.

The vacuum chamber had a bottom port (Fig. 2) which was used for most of the experimental work. The inherent filtration at this port was only 0.6 mm. aluminum. The arrangement of the port in relation to the target is shown in Figure 3.

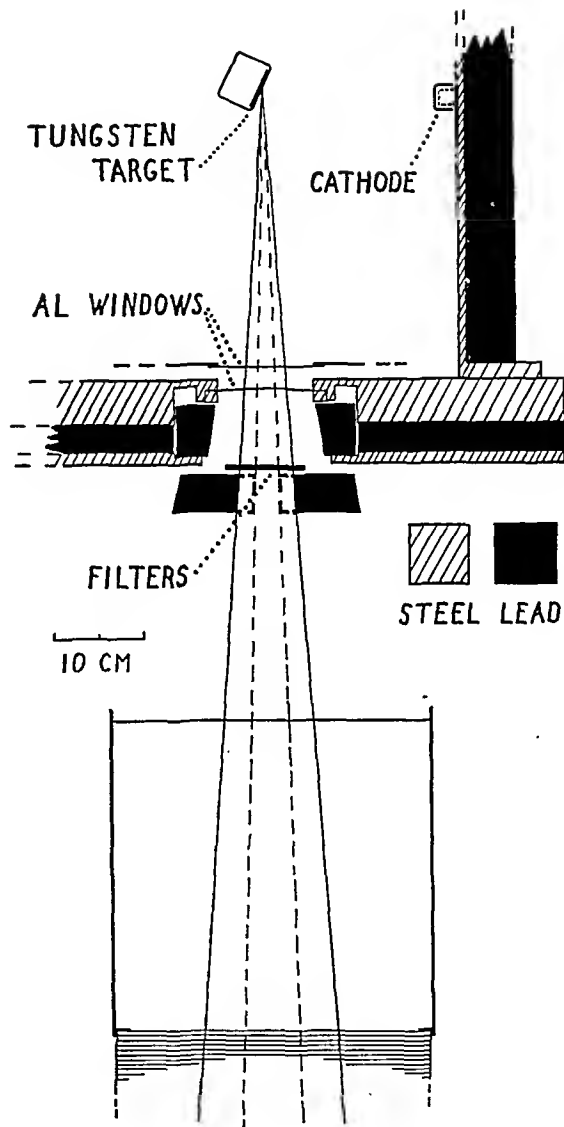


Fig. 3. Scale diagram showing arrangement of target, port, and phantom for measurements at 70 cm. f.s.d. The tungsten target is set in a water-cooled copper block shown in outline. The combined thickness of the two aluminum windows is 0.6 mm. A beam covering a field of 100 cm.<sup>2</sup> is shown in solid lines. The broken lines represent a 2.5 × 3.5 cm. aperture used in obtaining transmission curves. The phantom measures 35 × 35 × 35 cm. It has a presdwood bottom and sits on a pile of presdwood sheets about 20 cm. thick.

A number of side ports were available for control purposes.

The geometrical arrangement was such as to minimize off-focus and secondary radiation from inside the vacuum chamber. "Cold emission" x-radiation was negligible in amount in all experiments. With the hardest beam of radiation listed in Table II, cold emission measured at 70 cm.

f.s.d. and 400-cm.<sup>2</sup> field was only 0.2 per cent of the total intensity.<sup>4</sup>

The average emission current was read on calibrated millimeters on the control board.

As an output monitor, a galvanometer at the control desk could be switched either to a large ionization chamber at a side port or to a calibrating network. Since output per milliamper is a function of effective voltage, the galvanometer and millimeter together allowed any desired voltage setting to be held constant and reproduced at a later time.

The projected area of the focal spot for the vertical beam of x-rays was roughly  $1.5 \times 1.5$  cm. The position of the focus was accurately determined from vertical and horizontal pin-hole beams.

*B. Ionization Chamber:* The measurements described in this paper were made with a Victoreen condenser dosimeter. The same 25-r chamber was used throughout, *with additional wall material for the harder radiations*. Other chambers were used for monitoring and for special tests.

The 25-r chamber has a bakelite wall about 0.6 mm. thick, with a special inside coating. The wall is cylindrical with rounded end. The outside diameter and length are 12.5 and 23 mm. The central electrode is aluminum, about 1 mm. in diameter.

A second similar chamber and a smaller 100-r chamber were used as monitors at a side port in some of the work. As stated in the preceding paper, the calibration of these chambers has remained constant within 1 per cent over a period of years.

Caps of organic material (paper, lucite) were placed over the chambers when working at copper h.v.l.'s. of 7.4 and 8.7 mm. With the hardest rays the increase obtained by adding 1.5 mm. lucite to the chamber in a narrow beam was between 2 and 3 per cent. Readings under water were the same with or without the cap.

The holder for immersing the chamber and its condenser stem was made of a short piece of copper tube. At one end a rubber finger cot 0.05 mm. thick was attached, the other end being closed with a rubber stopper. The rubber cot was held closely against the chamber wall by wrapping with a few turns of silk thread each time the chamber was inserted. A little graphite powder shaken into the cot allowed the chamber to slip in and out easily.

It was found that when the butt end of the condenser is exposed to rays hard enough to penetrate the brass cap, there is a considerable amount of ionization. To avoid such an effect from scattered rays in the phantom, a lead shield was placed around the butt end of the holder.

No serious attempt was made to compare the Victoreen 25-r chamber with other chambers. To see whether the size of the chamber was sufficient to affect appreciably measurements near the surface, a single test was made in which the  $D_n/D_0$  ratio at 1 cm. depth (200 sq. cm., 70 cm. f.s.d., 1.35 mm. h.v.l.) was measured with the Victoreen 25-r chamber, a Victoreen 100-r chamber (10 mm. diameter), and a graphite chamber (4.5 mm. diameter). The measurements agreed within experimental error. ( $D_n/D_0$  was 0.997 by the 25-r chamber, 1.003 by the 100-r chamber, 1.00 by the graphite chamber.)

A wave length calibration of a Victoreen chamber given by Eddy (10), together with the manufacturer's claims, indicates that the readings of the chamber are independent of wave length from 2.0 mm. down to 0.5 mm. Cu h.v.l.

In the preceding paper it is shown that the effectiveness of x-rays in killing *Drosophila* eggs decreases by about 20 per cent as the h.v.l. is increased from 2 to 9 mm. of copper, if the radiation is measured with a Victoreen chamber. It was found, however, that *ratios* of surface or depth to free air measurements for three different h.v.l.'s were the same whether measured with the Victoreen chamber or with the eggs. Apparently the change of wave length by

<sup>4</sup> When the apparatus was first put into operation, an objectionable amount of cold emission was obtained at higher voltages. A new high-voltage coil with slightly wider spacing between turns eliminated this trouble.

scattering in the phantom is not great enough to change the biological effectiveness of the Victoreen unit of dose by an appreciable amount. It is concluded that the Victoreen chamber is suitable for depth dose measurements at all deep therapy h.v.l.'s.

*C. Phantom:* Water was chosen for the phantom material. A few comparative measurements on lean meat, fat, and "presdwood" are described at the end of Part 4 (p. 386).

The phantom was a cubical container  $35 \times 35 \times 35$  cm., shown in Figure 4. The sides were of zinc-coated steel sheet; the bottom was a sheet of masonite presdwood (untempered) 6 mm. thick, coated on the inside with asphalt. To provide sufficient back-scattering material for measurements near the bottom, the phantom was placed on a pile of presdwood sheets 20 cm. or more thick. Since the contribution of the presdwood to the measurements was small, the difference from water may be neglected.

To test whether the width of the phantom was sufficient, a presdwood phantom of the same dimensions was employed, with a beam of Cu h.v.l. 1.3 mm.; f.s.d. 70.7 cm.; field size 400 cm.<sup>2</sup> These conditions were chosen for maximum importance of side-scattering. Adding 7 cm. of presdwood to three sides of the phantom increased the intensity at a depth of 14 cm. by only 0.5 per cent.

The phantom was nearly filled with water, which was kept at room temperature to avoid disturbance of the chamber readings. Care was taken to prevent cooling of the chamber by evaporation from the wet surface of its rubber cover.

The mineral content of the water, including chlorine, as given by the city water department is equivalent in photoelectric absorption to 0.002 mm. of copper in the whole depth of the phantom.

Measurements at zero depth were made with the chamber half immersed. Simple but accurate positioning devices were used by which the chamber in its holder could be placed quickly and easily at any desired

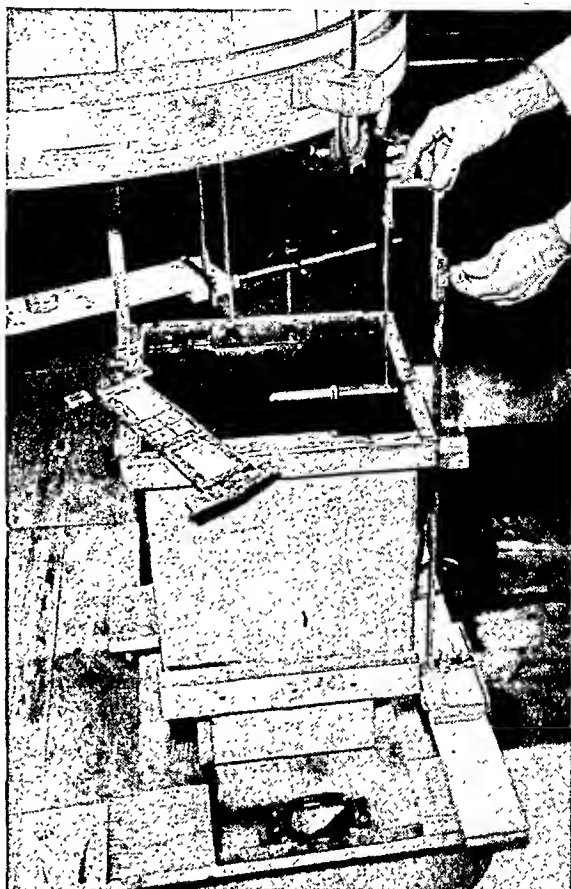


Fig. 4. Water phantom with chamber holder in surface position. A bakelite and cellophane holder used for exposing flies' eggs in the phantom is also shown (see preceding paper). The wooden frame supporting the phantom on the carriage was replaced by a pile of presdwood to give additional back-scattering.

position in the phantom. Depth settings were accurate to less than 0.5 mm. Focal distance and beam alignment were carefully maintained. To make measurements of exit doses, a special shallow water phantom was used. This phantom is described in Part 4 (p. 385).

## PART 2. ANALYSIS OF CONDITIONS FOR REPRODUCIBILITY OF SURFACE AND DEPTH DOSE MEASUREMENTS

As stated in the preceding paper, the disagreements found between phantom measurements published by different observers may be attributed to: (1) use of different dosimeters; (2) use of phantoms of different materials and dimensions; (3) inadequate specification of beams of radiation.

The aim of the present investigation was

TABLE I: RELATION OF INTENSITY MEASURED AT 70.7 CM. f.s.d. TO FIELD SIZE FOR THE RADIATIONS EMPLOYED IN DEPTH DOSE MEASUREMENTS  
(The field was defined by a single diaphragm as shown in Figure 3. The 18-cm.<sup>2</sup> beam was used in the measurements for transmission curves.)

Area (cm. <sup>2</sup> ) →	18	50	100	200	400
Cu h.v.l.					
0.11 mm.	1.00	1.007	1.013	1.022	1.036
1.35	1.00	1.011	1.015	1.026	1.039
5.2	1.00	1.015	1.022	1.032	1.058
8.7	1.00	1.023	1.035	1.072	1.095

to obtain phantom ratios which could be accurately reproduced by any experienced observer in another laboratory. To this end, a large water phantom and a widely available commercial dosimeter were used. It then remained to consider what beam conditions should be adopted and specified.

The characteristics of an actual beam of radiation may be discussed in relation to a beam of monochromatic rays from an ideal point source. To facilitate comparison with other workers, it is desirable to employ beams which approach the ideal as closely as practical considerations allow. The departure of actual beams from the ideal will be discussed under two headings: Geometrical Characteristics and Wave Length Composition.

#### A. Geometrical Characteristics of Beams

1. *Penumbra*: Due to the finite size of the focal spot, an actual beam is bounded by a penumbra. This should not affect the dose at the center of the field except in an extreme case where the greater average distance of the rays from the axis of the beam might appreciably reduce the amount of scatter at the center. For the narrowest beams used for phantom measurements in the present investigation, the defining diaphragm was placed only 5 cm. above the water surface to avoid possible penumbra effect.

2. *Off-focus Radiation*: Besides rays from the focal spot, the beam may contain "stem radiation," together with secondary rays from parts inside the tube, from edges of diaphragms, and from filters. These non-focal rays result in a progressive increase in the free air intensity measurement

as the beam width is increased by a diaphragm placed as in Figure 3. This increase is shown for several beams in Table I. Special tests using a dummy diaphragm and movable filter indicated that all the sources mentioned above contributed appreciably to the off-focus radiation. The large increases with field size seen in the hardest beams are chiefly due to scatter from the thick filters used.

Tests with the chamber placed outside the penumbra and covered on top with a thick piece of lead showed that floor scatter was negligible in all the beams described in the paper. The concrete floor, laid directly on solid earth, was 175 cm. below the target.

3. *Divergence Index*: Due to the presence of non-focal rays, as described above, the free air intensity will not follow the inverse-square law for distance from the focus, but will decrease more rapidly as a result of rays coming from less than the focal distance (as from the filter). In other words, the beam is on the average diverging more rapidly than the focal rays. To describe the average divergence of a composite beam at any focal distance— $f$  cm.—we use a "divergence index" which we define as:

$$\text{d.i.} = \frac{I_f + 25 \text{ (meas.)}}{I_f + 25 \text{ (calc.)}} = \frac{I_f + 25}{I_f \cdot f^2 / (f + 25)^2}$$

where  $I_f$  and  $I_f + 25$  represent *free air* intensities measured at  $f$  cm. and  $f + 25$  cm., respectively. For a beam obeying inverse-square law, the divergence index is unity. A value less than unity expresses the intensity at  $f + 25$  cm. as a fraction of the value calculated by the inverse-square law. The distance 25 cm. is chosen to correspond to the depth to which phantom measurements are commonly carried.<sup>5</sup>

For the beams employed in the present investigation, the divergence index was found to vary from unity to about 0.96, de-

<sup>5</sup> An alternative way of observing the relative intensity of focal and non-focal rays is by the data tabulated in Table I. The excess above unity shown in Table I is somewhat larger than the deficiency of the divergence index below unity for the same f.s.d.

pending chiefly on field size and focal distance. The largest field at highest voltage and thick filter shows a somewhat lower value. Instead of trying to correct all depth dose curves to unity divergence index we have adopted a divergence index of 0.98 as normal. Variations of  $\pm 2$  per cent (1.0 to 0.96) will not significantly affect depth dose measurements from a clinical standpoint, although it will be shown in Part 4 that the effects of such differences are in some cases easily measurable.

Special tests were made which seem to indicate that, within the limits imposed by keeping the divergence index near unity and avoiding excessive penumbra, the positions of diaphragms and filters may be varied at will without significantly affecting the relation of phantom intensities to field area.

4. *Lateral Intensity Distribution:* Due to the non-uniform directional emission of x-rays, as well as to absorption in the target and tube wall, and to the greater distances to the edges of the field compared to the center, there may be a considerable variation in intensity about the axis of the beam. Such lack of uniformity would be expected to be greatest at high voltages (11). The departures of the intensity in our widest 1,000-kv. beam from the value at the center are shown in Figure 5. Since the intensity at the edge of the field affects only a small portion of the scatter received at the center, it is estimated that phantom measurements at the center of the field will not be in error by more than 1 or 2 per cent as a result of the distribution shown in Figure 5, which represents our worst case.

5. *Diaphragm Transmission:* If the diaphragms are too thin, the additional radiation transmitted outside the aperture will be scattered in the phantom into the center of the field. By inspection of the curves showing  $D_n/D_0$  ratios in relation to field size (Figs. 9a-k), it appears that in the worst cases (narrow beams, great depths) the measurements will not be in error by more than the order of 1 per cent if the diaphragm transmits not more than 0.002

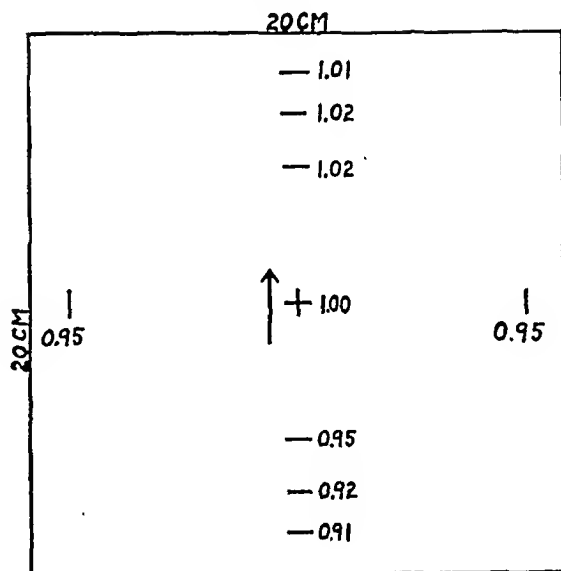


Fig. 5. Intensity distribution over  $20 \times 20$  cm. field in air 70.7 cm. below focal spot, 8.7 mm. Cu h.v.l. The direction of the electron stream is shown by the arrow.

of the filtered radiation intensity. At higher voltages this requires lead diaphragms up to 4 or 5 cm. in thickness.

#### B. Wave Length Composition of Beams

1. *Half-Value Layer and Homogeneity Coefficient:* The wave length composition of a beam of x-rays depends on excitation voltage (peak value and wave form), filtration (inherent and external), direction from electron stream, and target material. It is usually difficult to reproduce all these factors in different laboratories, at least for the higher voltages. It is better for the purpose of the present discussion to specify quality in terms of narrow beam transmission curves in suitable absorbing materials. The same ionization chamber was used for the absorption measurements as for the rest of the experiment.

The narrow beam transmission curve for a monochromatic radiation plots as a straight line on semi-logarithmic paper. The h.v.l. obtained from such a curve specifies the beam quality completely (between absorption jumps). A heterogeneous beam gives a logarithmic transmission curve which is concave upward. The ratio of second to first h.v.l. obtained from such a curve is greater than unity the

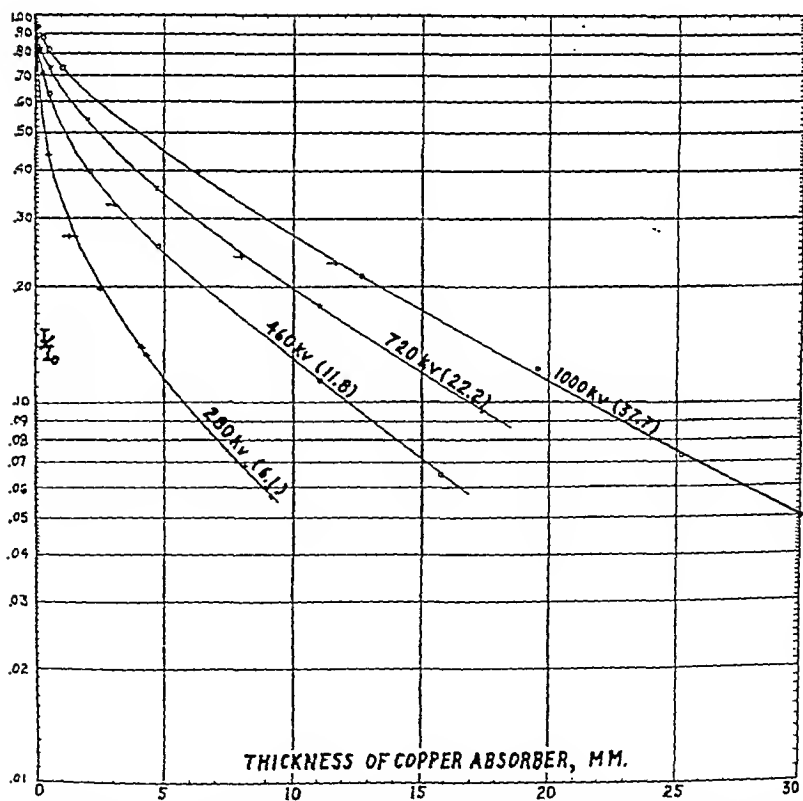
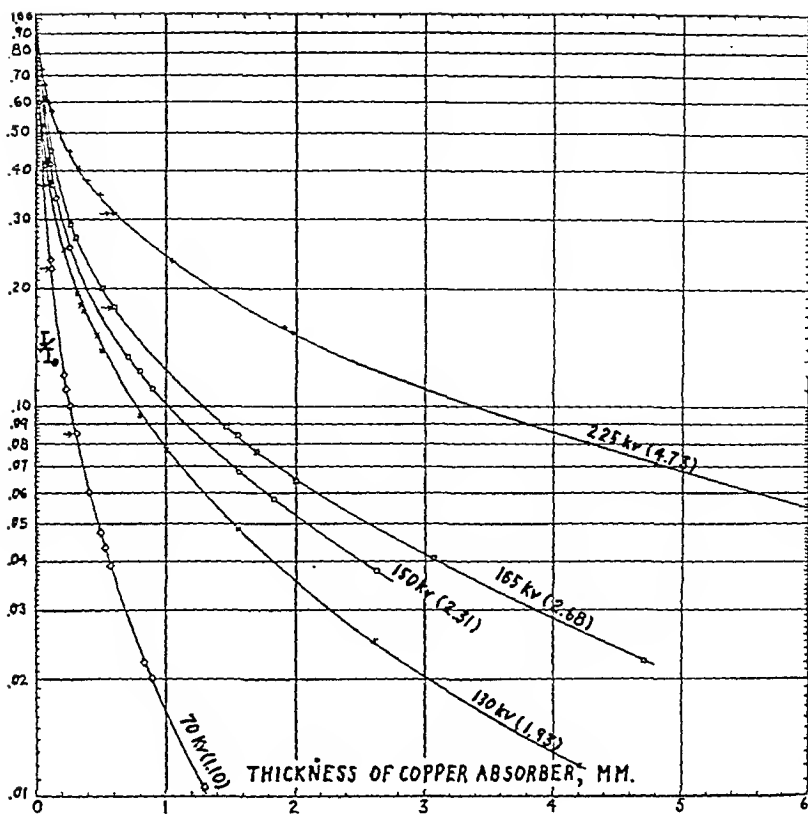


Fig. 6a and b. Copper transmission curves for radiations with no initial filtration except the window of the tube (0.6 mm. Al). [Legend cont. on opposite page.]

more heterogeneous the beam. This ratio has been called the homogeneity coefficient, denoted by  $h$ .

2. *Homogeneity Coefficient in Water:* The representation of depth dose ratios would be greatly complicated by the introduction of more than one variable to indicate quality. It seems reasonable to suppose that a heterogeneous radiation whose narrow beam transmission curve *in water* is not appreciably curved will not differ significantly from a monochromatic beam of the same h.v.l. in its wide beam distribution in a phantom. For beams filtered so as to satisfy this condition, the h.v.l. in any convenient material should be a sufficient specification of quality.

Copper is well suited for h.v.l. measurements over the whole range of deep therapy wave lengths. Even for the hardest radiations now in use, there seems little need to change to lead, since the variation of absorption with wave length in tissue is never more rapid than in copper.

Transmission curves in water and copper were obtained for all the radiations used in the present study, as described in Part 3. For the two hardest beams lead h.v.l.'s were also measured.

An experiment with an inhomogeneous beam is described in Part 4 and discussed in Part 5. The results of this test, shown in Fig. 9*b*, indicate that a rather slight curvature of the water transmission curve has an appreciable effect on the depth dose curves.

3. *Characteristic Radiation:* The h.v.l.'s obtained from narrow beam measurements are used to describe the corresponding wide beams used for phantom measurements. The forward scattering from filters, diaphragms, etc., will not differ greatly in wave length from the focal radiation. Characteristic radiation, however, might cause error if present in appreciable amount. Tests for characteristic radiation

in the beams used for depth measurements are described in Part 3.

### PART 3. SPECIFICATION OF QUALITY OF BEAMS TO BE EMPLOYED IN THE FOLLOWING DEPTH DOSE EXPERIMENTS

In accordance with the discussion in Section B of Part 2, narrow beam transmission curves will be used to describe the radiations to be used in Part 4. In all narrow beam transmission measurements a diaphragm of  $2.5 \times 3.5$  cm. was used in the position shown in Figure 3. The filters and metal absorbers were placed on top of the diaphragm. Water absorbers were placed directly under the diaphragm. To hold the water, a piece of brass tubing 5 cm. in diameter, closed at one end with 1 mm. celluloid sheet, was used. To avoid meniscus error, the water level was measured from the top, using a blunt metal point coated with vaseline.

The 25-r chamber, described in Part 1, was placed at a sufficient focal distance, usually 100 or 122 cm., to receive the transmitted beam without an appreciable amount of scatter from the absorbers. Background was usually negligible, but in one or two cases a small correction was made at the lower end of the curve.

The beams of radiation used for the depth dose measurements were produced with voltages of widely different wave form. At the lowest voltage the cathode was unbiased, while the higher voltages were well biased. The exact relation of minimum to peak voltage in any case is not known.

To specify quality as completely as possible, the following procedure was employed. For each voltage setting, a copper transmission curve was obtained for the radiation emerging from the 0.6 mm. Al window of the vacuum chamber. These curves are shown in Figures 6*a* and *b*, together with the outputs in r/min. per milli-

*Legend for 6a and b cont.*

The outputs ( $I_0$ ) in r/min. per milliamper at 100 cm. from the target are shown in parentheses beside each curve for the initial beams coming from the window.

The voltages specified are "equivalent constant potentials" estimated from the curves as explained in the text. An intensity equal to that of the filtered beam used for depth dose measurements is indicated on each curve by an arrow. In those cases where copper filtration was used, the curve below the arrow is reproduced in Figs. 7*a* and *b*.



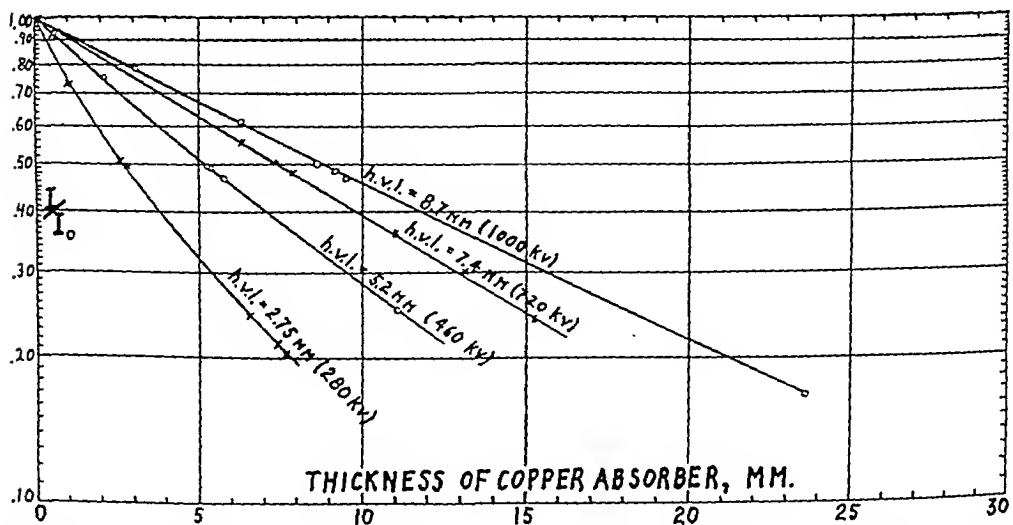
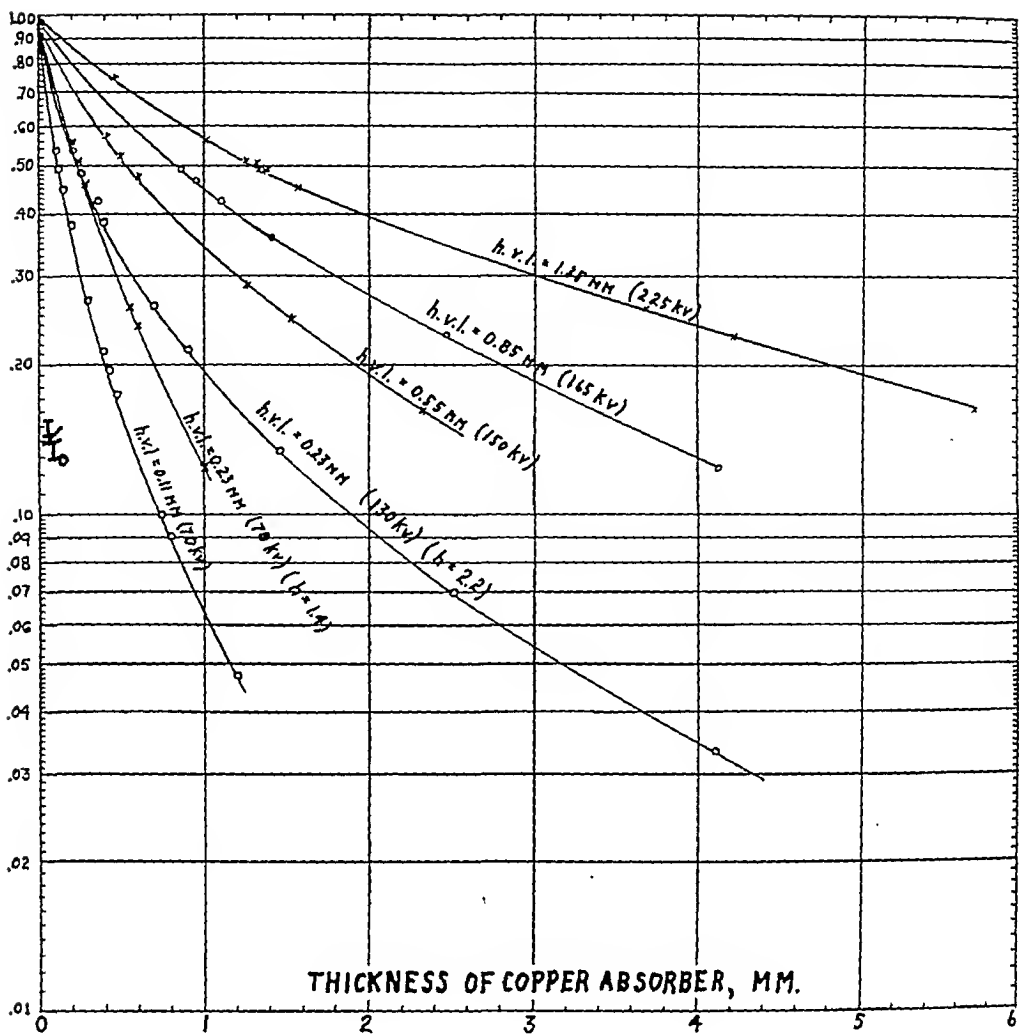


Fig. 7a and b. Copper transmission curves for beams used in depth dose experiments. (See Table II.)

TABLE II: DATA ON DEPTH DOSE BEAMS

Copper, h.v.l.	h	Water, h.v.l.	h	Pb, h.v.l.	Filter, mm.	Milli- amperes	Output*	Equivalent Constant Potential
0.11 mm.	1.8	2.2 cm.	1.1	...	0.075 Cu + 1.05 Al	16.4	0.25	70 kv.
0.23	1.4	2.7	1.1	...	0.305 Cu	16.4	0.093	70
0.23	2.2	2.7	1.1	...	0.11 Cu	30.0	0.71	130
0.55	1.8	3.2	1.1	...	0.305 Cu	30.0	0.54	150
0.85	1.7	3.7	1.0+	...	0.60 Cu	30.0	0.48	165
1.35	1.8	4.1	1.0+	...	0.60 Cu	15.2	1.48	225
2.75	1.4	...	...	...	1.51 Cu	20.2	1.73	280
5.2	1.1	5.3	1.0	...	1.03 Sn + 1.1 Cu	4.1	3.83	460
7.4	1.0	6.0	1.0	1.73 mm.	1.02 Pb + 1.53 Sn + 0.25 Cu	4.1	5.4	720
8.7	1.1	6.8	1.0	2.95	2.1 Pb + 3.15 Cu	2.6	8.7	1000

\* Output is given in r per minute per milliamperes at 100 cm. from the focus.

ampere at 100 cm. from the focus with only the inherent filtration (0.6 mm. Al).

From the unfiltered outputs and the transmission curves, outputs and h.v.l.'s can be found for any desired copper filtration for comparison with published values. From such comparisons with published data obtained with constant potential excitation, equivalent constant potentials have been estimated for our radiations and are used to identify the different voltage waves represented by the curves. For the higher voltages, the comparison was based on outputs for 0.5 mm. Cu given by Kaye and Binks (12) and for 2.5 mm. Cu by Bouwers and van der Tuuk (13). The lower voltage estimates are based mainly on h.v.l. comparisons. No attempt was made to determine how closely the estimated equivalent constant potential would apply over the whole transmission curve.

With each of these voltage waves and a suitable filter, a beam for a depth dose experiment was obtained (two beams were obtained from the lowest voltage with different filters). Copper transmission curves for the filtered beams are shown in Figures 7a and b. In those cases where a copper filter was used, the curves for the filtered beams are taken from the corresponding portions of the curves in Figures 6a and b. Otherwise, separate measurements were made.

Transmission curves for water are shown in Figure 8. Because of technical difficul-

ties, the water transmission measurements are less precise than those with copper. But it is found that the water transmission curves are substantially straight except for the very soft beams. To test the effect of non-homogeneity on phantom ratios, two beams of h.v.l. 0.23 mm. Cu, but different homogeneity coefficients, were used.  $D_x/D_0$  ratios for these beams are plotted in Figure 9b and are discussed in Part 4.

For the two hardest beams, h.v.l.'s in lead were obtained. In Table II is assembled information about the beams used in the depth dose experiments.

A number of tests for the presence of characteristic radiation in the depth dose beams will now be described. To test for K radiation from a copper filter, intensity measurements were made with the copper filter placed first below and then above a 1-mm. Al filter. If the ratio of the first to the second reading is greater than unity, the increase is due to K radiation from the copper. Tests were made with four of the depth dose beams described in Table II, and similar tests for Pb K and L radiation were made with the hardest beam:

1. Cu h.v.l. 8.7 mm., field 400 cm.<sup>2</sup>, filter 2.1 mm. Pb + 3.15 mm. Cu + 1.0 mm. Al, 28 cm. above chamber (Fig. 3). Ratio (Al up/Al down) is 1.001. No detectable amount of K radiation.

2. Cu h.v.l. 1.35 mm., field 400 cm.<sup>2</sup>, filter 0.6 mm. Cu + 1.0 mm. Al, 28 cm. above chamber. Ratio (Al up/Al down) 1.001. No detectable amount of K radiation.

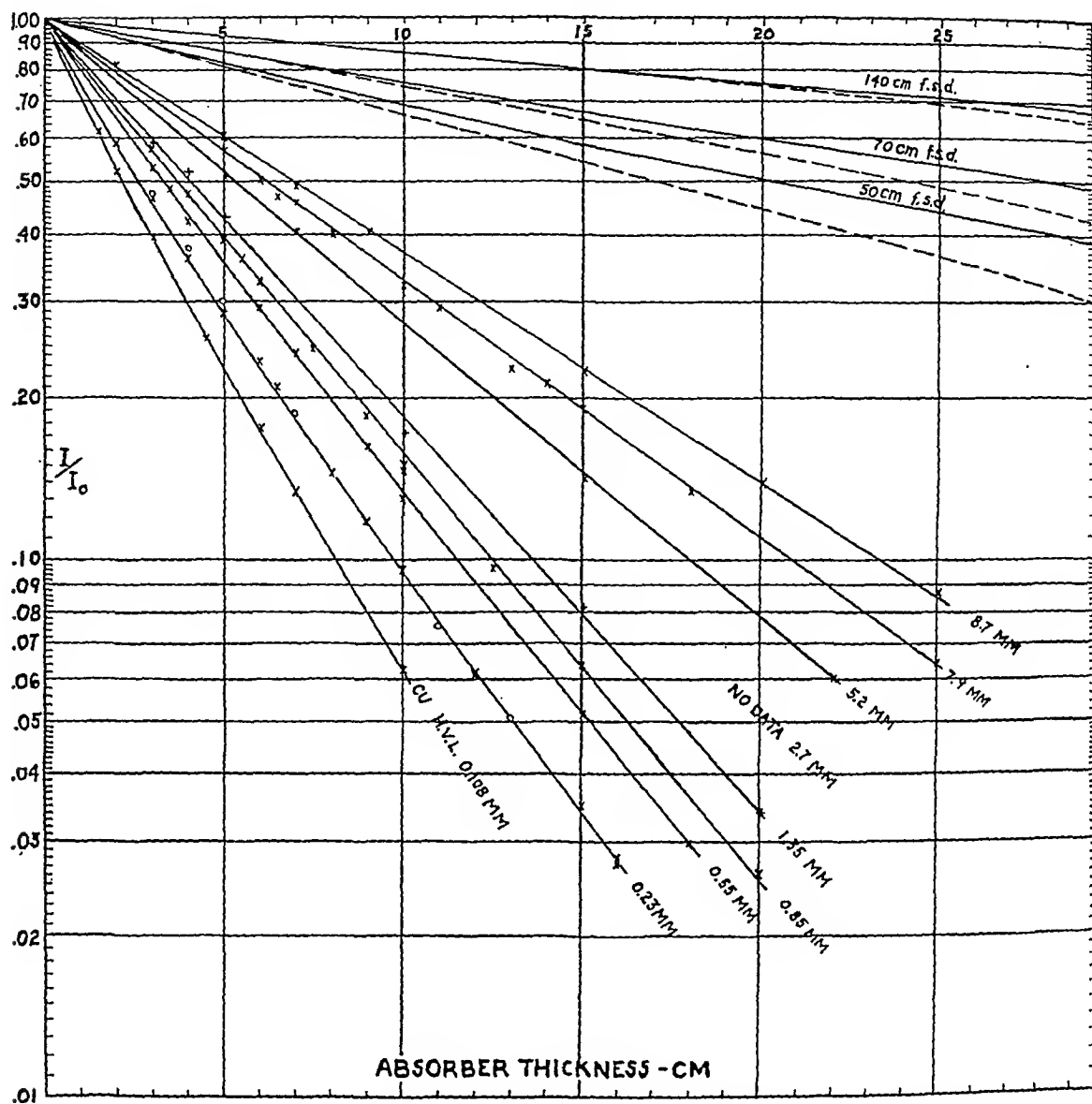


Fig. 8. Transmission curves in water for the beams used in depth dose experiments. (See Table II.) Copper h.v.l.'s are indicated for each curve. The measurements for 0.23 mm. Cu h.v.l. with  $h = 0.22$  and  $0.14$  are shown by crosses and circles, respectively.

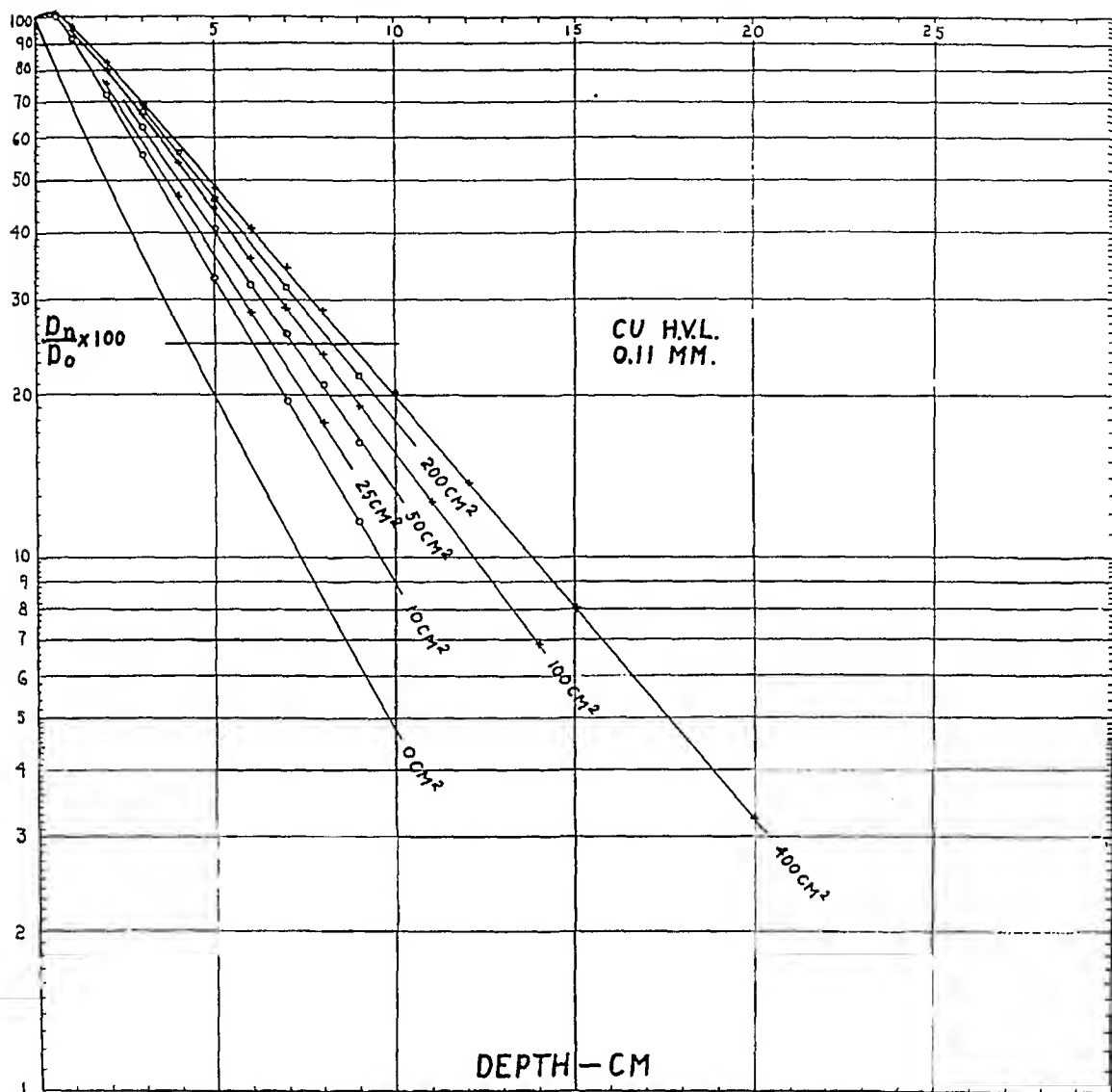
At the top of the chart, inverse-square law curves and their exponential approximations are shown by solid and broken lines, respectively.

3. Cu h.v.l. 0.11 mm., field 400 cm.<sup>2</sup>, filter 0.075 mm. Cu + 1.0 mm. Al, 28 cm. above chamber. Ratio (Al up/Al down) 1.02. Since 2 per cent of Cu K radiation is thus shown to be present, the Al filter was used with this beam.

4. Cu h.v.l. 0.23 mm.,  $h = 1.4$ , field 100 cm.<sup>2</sup>, filter 0.31 mm. Cu + 1 mm. Al, 5 cm. above chamber. The excess intensity measured with the filters in this position compared to a narrow beam with filters at 28 cm. was 11 per cent with Al up and 5 per cent with Al down. Hence characteristic radiation accounts for about half of the excess radiation in the wide beam. No Al filter was used in the depth dose measurements with this beam, but the air, surface,

and 1 cm. depth intensities were corrected for the characteristic radiation present, which would be absorbed by a thin layer of water.

5. A test for Pb K radiation was made as follows: Cu h.v.l. 8.7 mm., f.s.d. 70.7 cm., field 100 cm.<sup>2</sup>, filters 2.1 mm. Pb + 3.1 mm. Cu, 2 cm. above chamber. The excess obtained over the intensity for a narrow beam with the filters 28 cm. above the chamber was 25 per cent for Cu down and 21 per cent for Cu up. The increase for Cu down cannot be explained as Cu K radiation, which would not be appreciable with such a hard primary beam. Rather the scattering from the lead is diminished, compared to copper, by photoelectric absorption of scattered

Fig. 9a.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

rays. The copper filter was used, not to absorb characteristic radiation, but to help filter the primary wave lengths longer than the Pb K absorption limit.

A test for Pb L radiation was made with the same voltage and geometry as in the Pb K test. Filters 2.1 mm. Pb + 1 mm. Al. Ratio (Al up/Al down) was 0.995, giving no evidence of Pb L radiation.

#### PART 4. SURFACE AND DEPTH DOSE MEASUREMENTS

With the apparatus described in Part 1, surface and depth measurements were made for the beams described in Part 3. A few exit dose measurements were also made. The phantom measurements were

made at focal-skin distances of 50, 70.7, and 141.1 cm. These distances were chosen for convenience in testing inverse-square law relations.

Figure 3 shows the geometrical arrangement for measurements at 70.7 cm. Square fields were used in all cases. Lead diaphragms about 4 cm. thick were employed. The edges were tapered to match, approximately, the divergence of the beams. Field sizes 10, 25, 49, 97, 190, and 385 cm.<sup>2</sup> were used. In the charts which follow, these fields are designated by the nearest round numbers for simplicity of presentation.

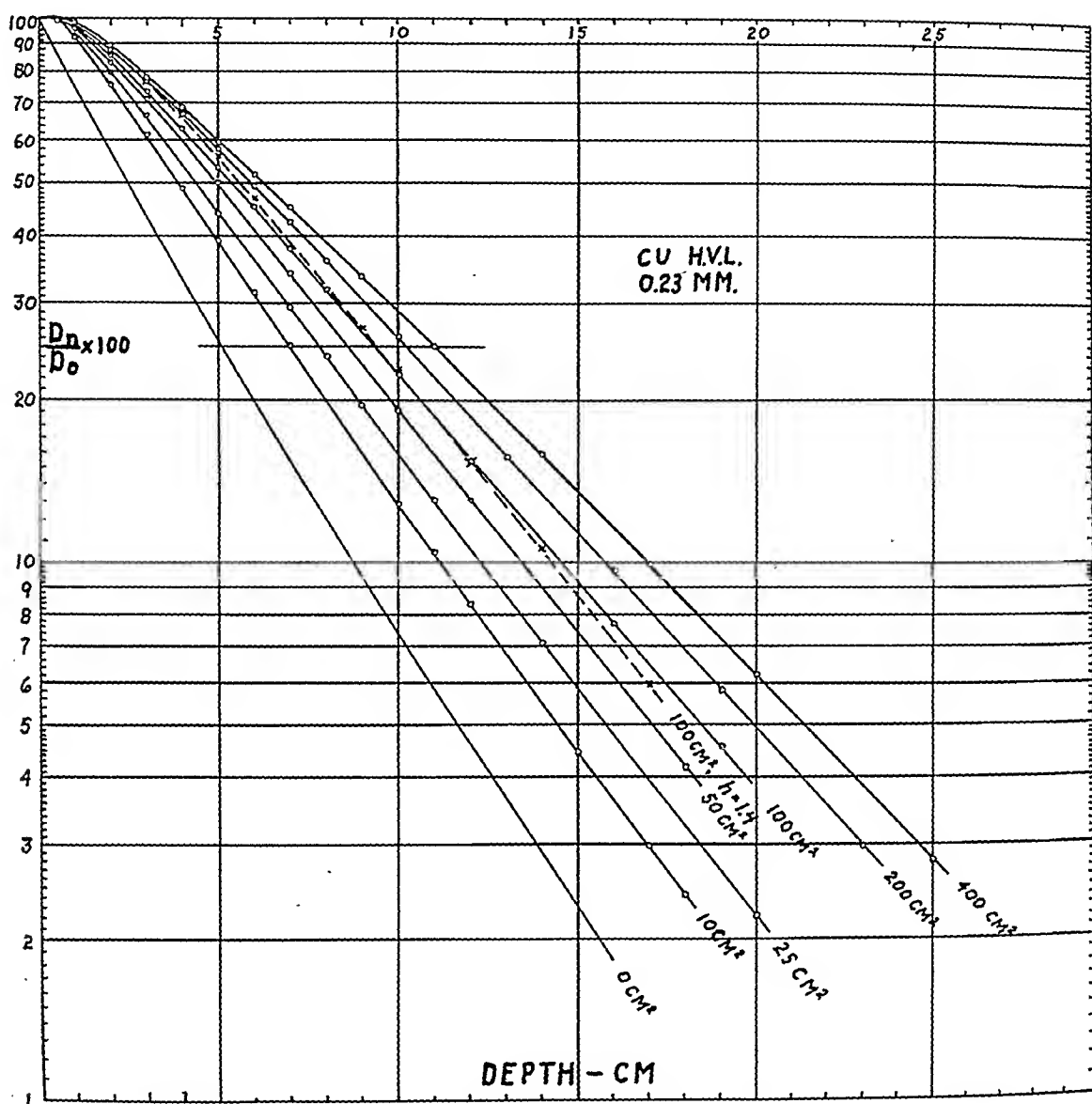


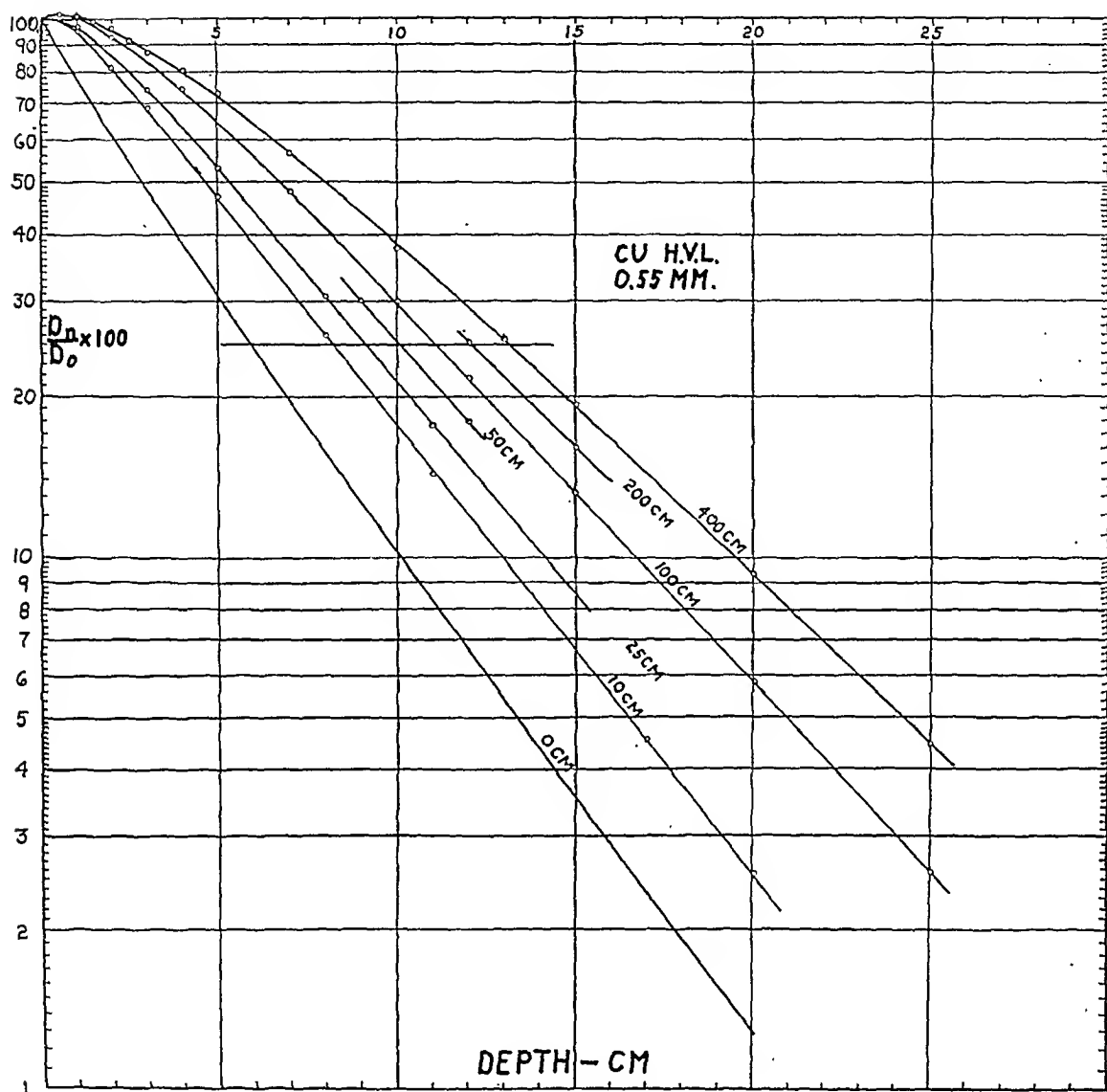
Fig. 9b.  $D_n/D_0$  ratios, 70.7 cm. f.s.d. Solid lines:  $h = 2.2$ . Broken lines:  $h = 1.4$ .

For measurements at 141.4 cm., the defining diaphragm was placed from 30 to 55 cm. above the surface. The filter and a supplementary diaphragm were placed as in Figure 3. For the measurements at 50 cm. f.s.d., special filters and diaphragms were made which could be fitted immediately below the aluminum window of the vacuum chamber. For the 10-cm.<sup>2</sup> beam at all f.s.d.'s the defining diaphragm was placed 5 cm. above the surface to avoid having an excessive portion of the total radiation in the penumbra zone.

From the free air and phantom intensity measurements, surface to air and depth to

surface ratios were calculated for each beam and field size. The  $D_0/D$  ratios are shown in Figure 12 and  $D_n/D_0$  ratios in Figures 9a-k.

The detailed procedures employed in order to keep all conditions constant during a series of measurements will not be described, as different methods might be more appropriate in another laboratory. Because of the number and complexity of the experimental conditions to be checked and kept under control, it was found that the better part of a day was usually spent getting ready to start a series of measurements. Most of the observations were

Fig. 9c.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

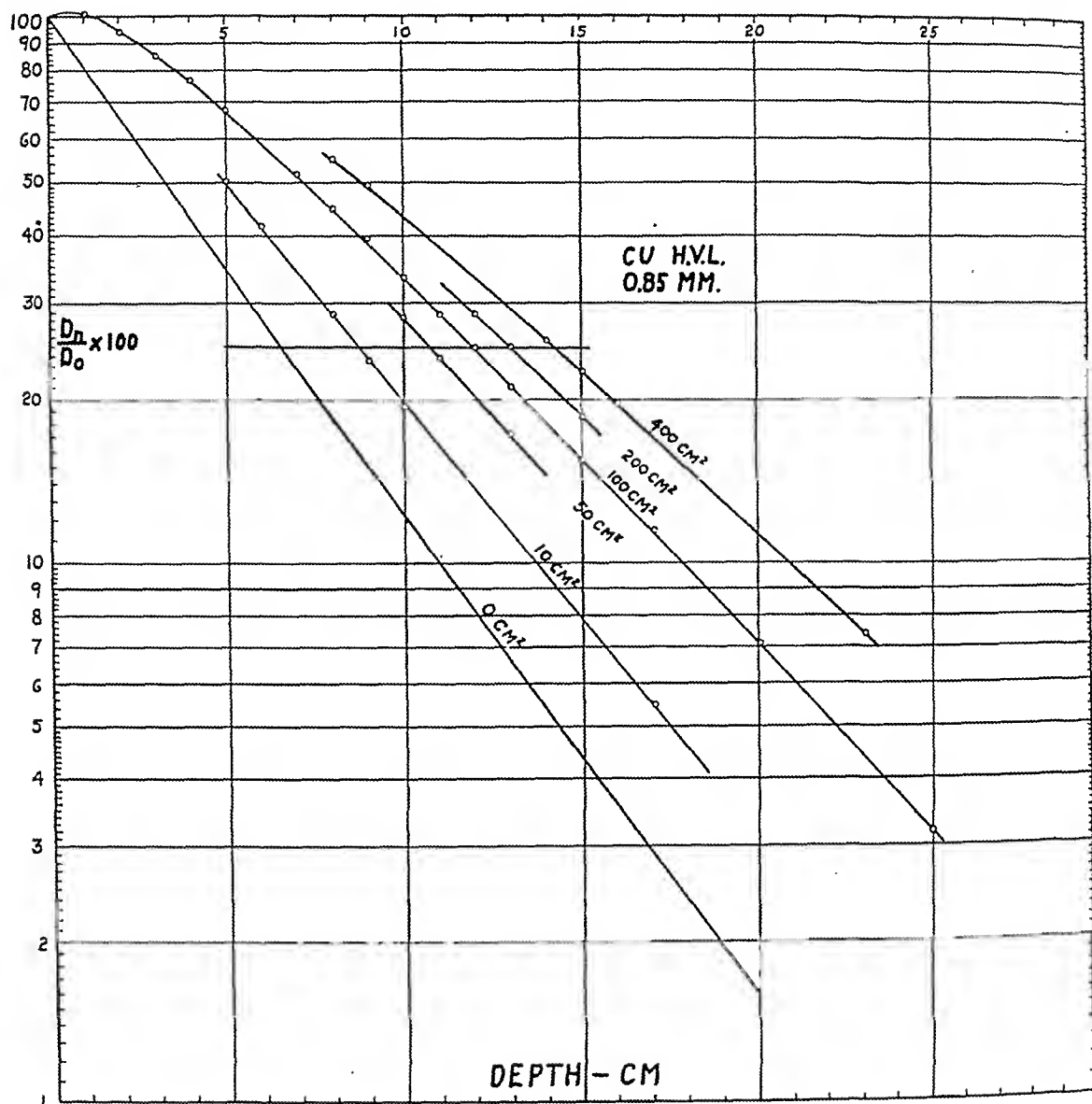
therefore made in continuous runs of twenty-four to thirty-six hours.

In some experiments a series of free air and phantom measurements was made while the output was held constant with the help of a large ionization chamber and galvanometer. (See description of generator in Part 1.) The free air measurement could be held constant for hours or even days with an average deviation of 0.5 per cent or less.

In other experiments each measurement at the bottom port was accompanied by a monitor measurement with another Victoreen chamber at a side port. In order to

have monitor readings matching in precision the measurements at low intensities in the phantom, three different focal distances at the side port were calibrated in relation to the bottom port. This method is convenient, in that accurate timing of the exposures is not required.

Several readings were taken for each free air and surface intensity. Most of the depth intensities were observed only once. The precision of the dosage measurements can be judged from the closeness with which the plotted points lie along the  $D_n/D_0$  curves in Figures 9a-k. In most cases where a point deviated more than 1

Fig. 9d.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

or 2 per cent<sup>6</sup> from the curve, a mistake was found in the slide-rule calculation. An exception which is probably due to an experimental blunder is seen on the 400-cm.<sup>2</sup> curve of Figure 9i at 22.5 cm. depth.

An example of the reproducibility, as distinguished from the precision, of the measurements is given by the  $D_n/D_0$  ratios for

<sup>6</sup> In examining the curves, it is useful to bear in mind that on logarithmic rulings a given displacement from the curve (in actual distance, e.g., 10 mm.) represents the same fractional deviation on all parts of the scale. For example, the ordinate distance from 10 to 11 is the same as from 50 to 55. Hence, any point whose deviation from the curve is equal to the distance between 98 and 100 per cent rulings shows a fractional deviation of 2 per cent.

100 cm.<sup>2</sup> in Figure 9e. The data represented by circles in this graph were taken in June 1941. During the summer the phantom and all positioning installations were taken down in order to make some alterations in the x-ray generator. The following January, with the apparatus again set up and completely realigned, the measurements shown on the curve by squares were made. On various other occasions parts of curves were repeated with similar agreement.

The curves for zero area (primary beam without scatter) shown in Figures 9a-i, are obtained by combining the narrow



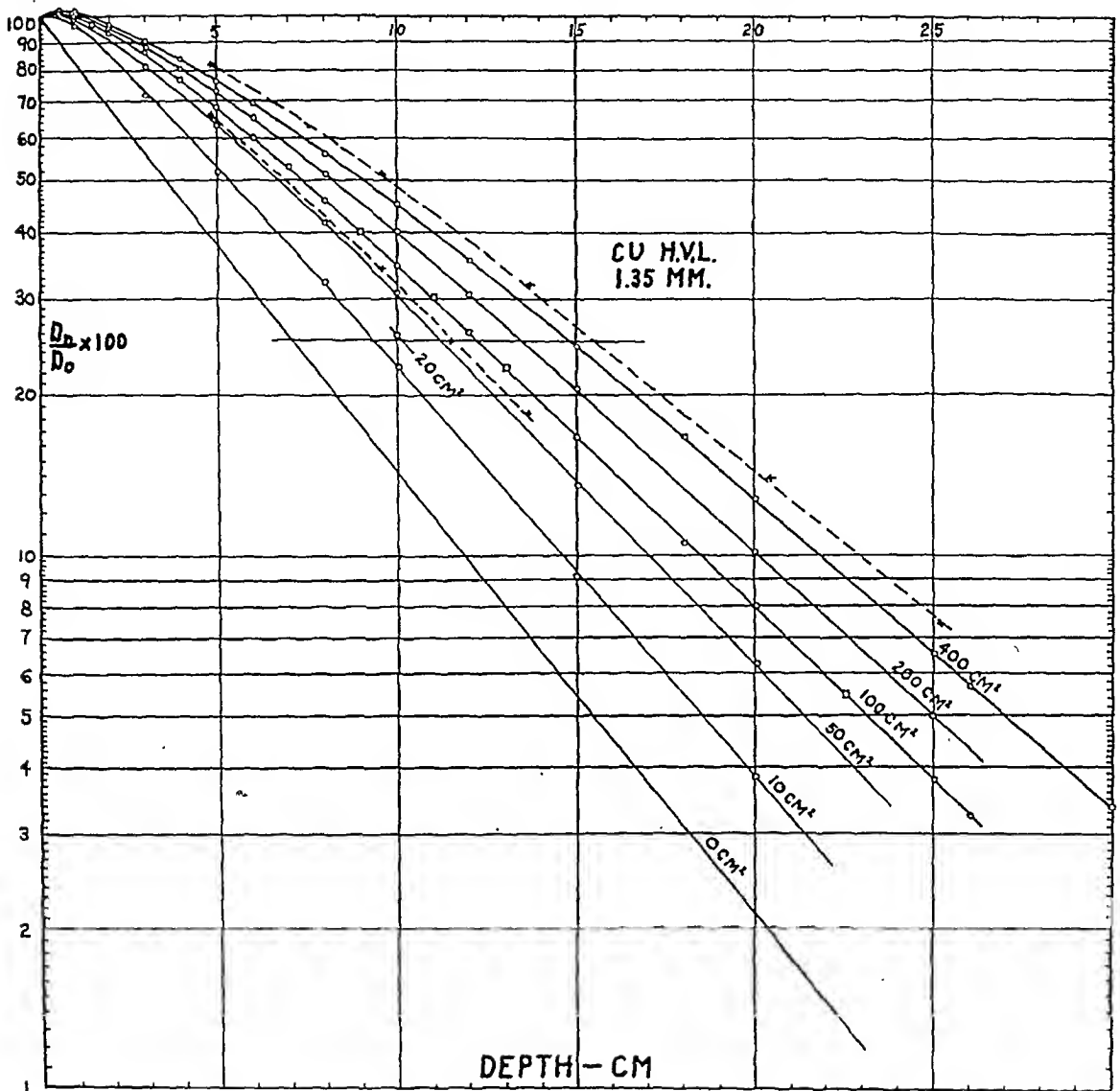


Fig. 9e.  $D_n/D_0$  ratios, 70.7 cm. f.s.d. Ratios in presdwood for 50 and 400-cm.<sup>2</sup> fields shown by broken lines.

beam water transmission curves of Figure 8 with inverse-square law. These curves are slightly concave upward for two reasons. The transmission curve itself is not perfectly straight, and the inverse-square factor curves up slightly on logarithmic paper.<sup>7</sup> In some of the  $D_n/D_0$  curves for

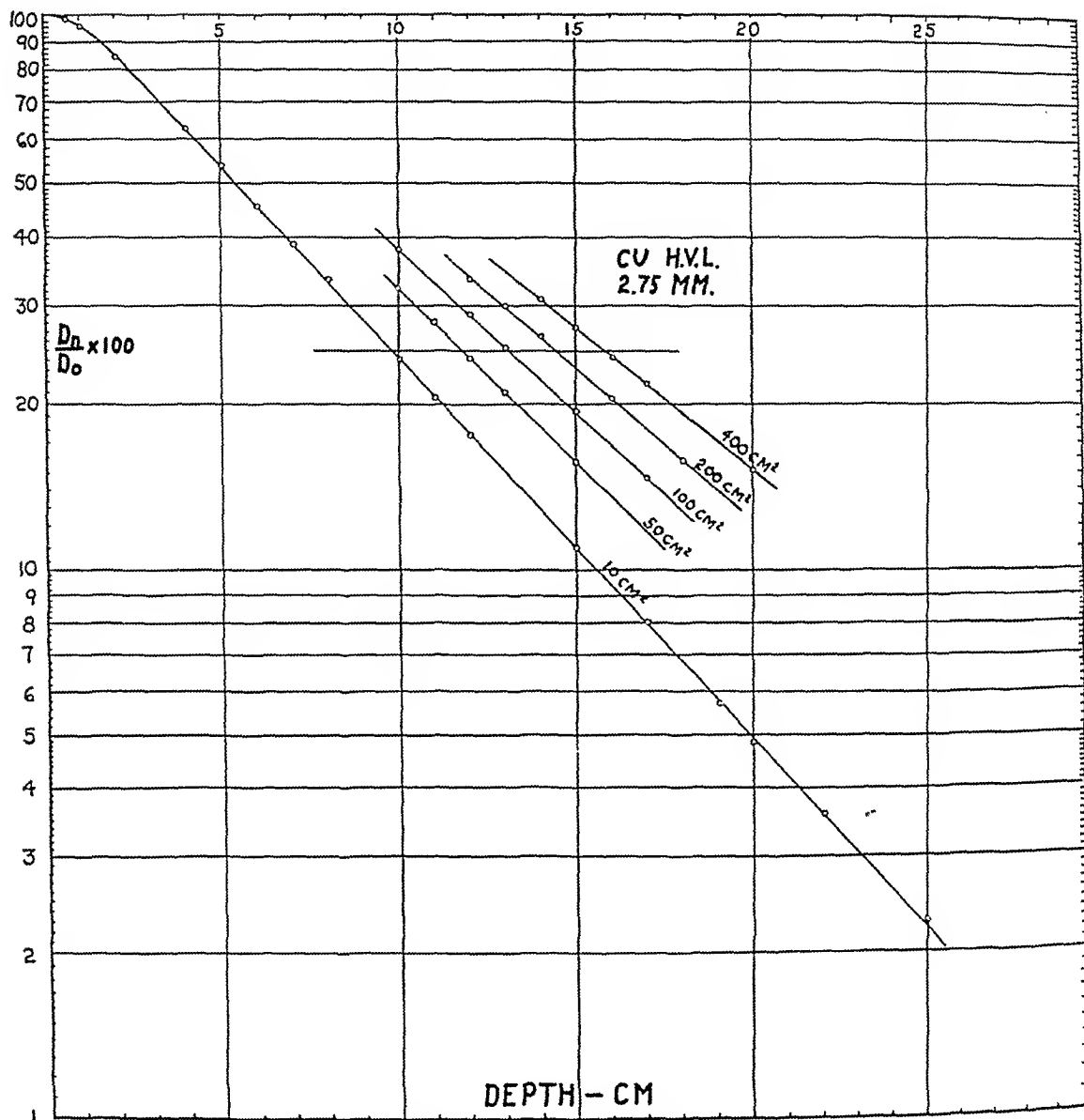
<sup>7</sup> For moderate depths, especially at large f.s.d.'s, the expression  $e^{-2d/f}$  gives a fair approximation to inverse-square law for primary beam, where  $f \approx$  f.s.d. and  $d =$  distance below the surface. This can be seen from the following comparison:

$$\begin{aligned} [f/(f+d)]^2 &= (1+d/f)^{-2} \\ &\approx 1 - 2d/f + 3f^2/d^2 - 4f^3/d^3 + \dots \\ e^{-2(d/f)} &= 1 - 2d/f + 2f^2/d^2 - 4/3f^3/d^3 + \dots \end{aligned}$$

For comparison the exponential approximations to three inverse-square curves are shown in Figure 8.

narrow beams and low h.v.l.'s this upward curvature is detectable in their lower portions.

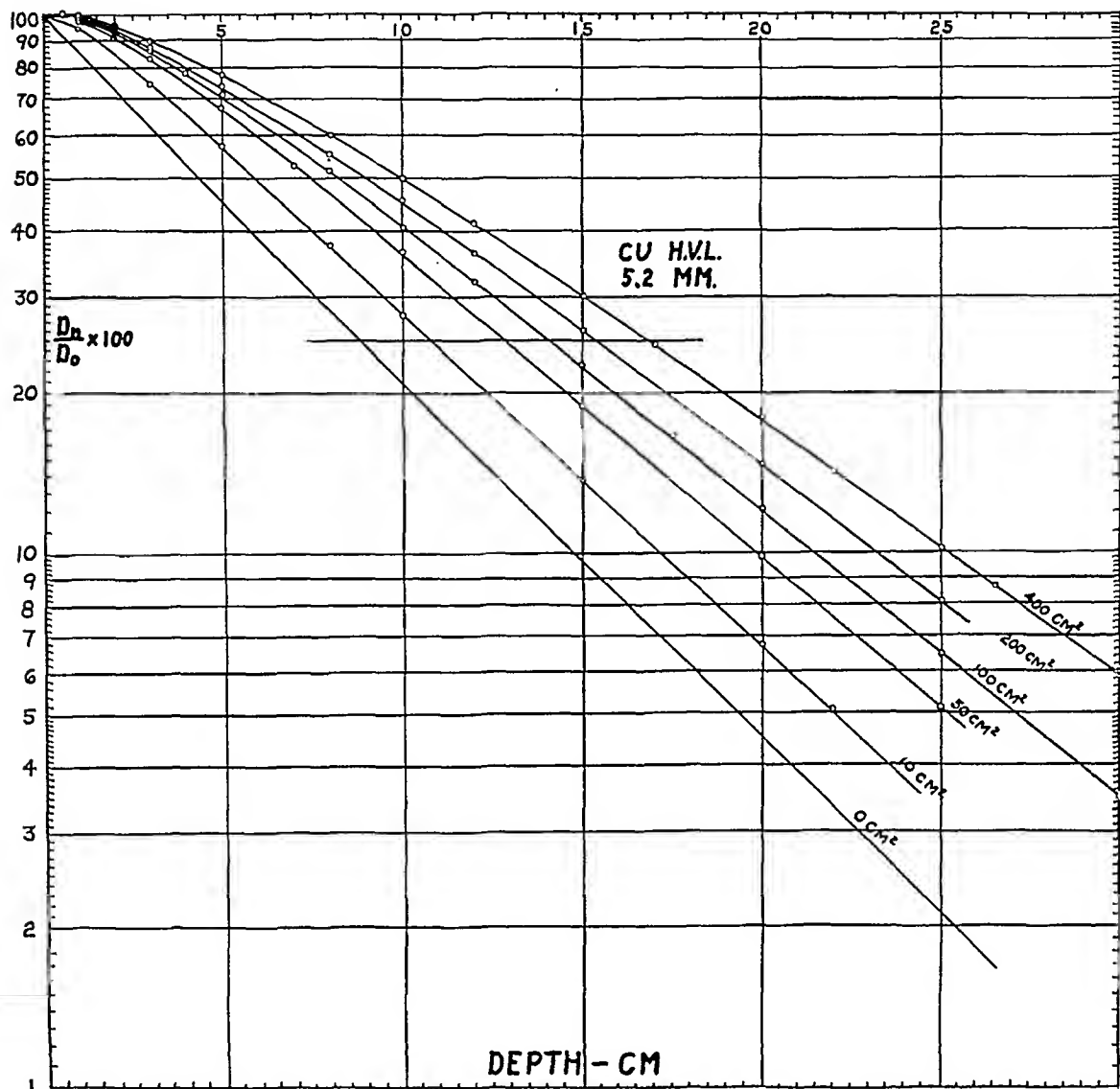
In Part 2, a "divergence index" was defined as a means of expressing the average divergence of a beam containing radiation scattered from filters, diaphragms, etc. Curves A and B in Figure 9k give  $D_n/D_0$  ratios for two beams having divergence indices of unity and 0.95, respectively. The conditions were the same for the two beams except that for A the filter was 100 cm. above the surface and for B 15 cm. Scatter from the lower filter position increased the free air dose at the

Fig. 9f.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

surface position by 6 per cent, while 25 cm. lower the increase was only 1 per cent. These observations are in accordance with an inverse-square law divergence of the scatter from the filter regarded as the source of the additional radiation. It is seen that in the lower portion of curves A and B, corresponding ordinates differ by 5 per cent. Since at 25 cm. depth the primary beam (Fig. 9i) comprises only one-third of the total intensity, it appears that not only the primary beam but also the scatter falls off more rapidly with depth if the divergence index is less than unity. Such a result may be explained by the fact

that divergent rays will be scattered into the center of the field from greater distances on the average than will parallel rays. The importance of such an effect would be expected to vary with field size and other conditions. From the present comparison it may be said that  $D_n/D_0$  ratios at the greater depths may in some cases be diminished, at least in proportion to the divergence index.

To observe the effect of non-homogeneity on  $D_n/D_0$  ratios, two beams having a copper h.v.l. of 0.23 mm. and homogeneity coefficients of 2.2 and 1.4 were employed.  $D_n/D_0$  curves for a 100-cm.<sup>2</sup> field are

Fig. 9g.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

given for both beams in Figure 9b. These results are discussed in Part 5.

Some measurements in a "presdwood" phantom were made for comparison with the water data. The phantom had the same dimensions as the water phantom. It was made by piling up flat pieces of masonite untempered presdwood 6.7 mm. thick. A close-fitting cavity was made for the dosimeter. The average density of the presdwood was 1.015 gm./cm.<sup>3</sup> However, it was found that the density of individual pieces cut from the same large sheet varied from 0.96 to 1.07 gm./cm.<sup>3</sup> Light and heavy pieces were alternated in the phantom.

In Figure 9e,  $D_n/D_0$  ratios in presdwood for 1.35 mm. Cu h.v.l. and 50 and 400 cm.<sup>2</sup> are shown by broken lines. It is seen that at 25 cm. depth and a 400-cm.<sup>2</sup> field the ratio for presdwood is 15 per cent larger than for water. At 8.7 mm. Cu h.v.l., 12.5 cm. depth, and 400-cm.<sup>2</sup> field the  $D_n/D_0$  ratio was only 2 per cent higher than for water. At both h.v.l.'s the  $D_0/D$  ratios were smaller than for water by less than 2 per cent. Some narrow beam transmission measurements were also made on presdwood, with results as shown in Table III.

A few narrow beam transmission meas-

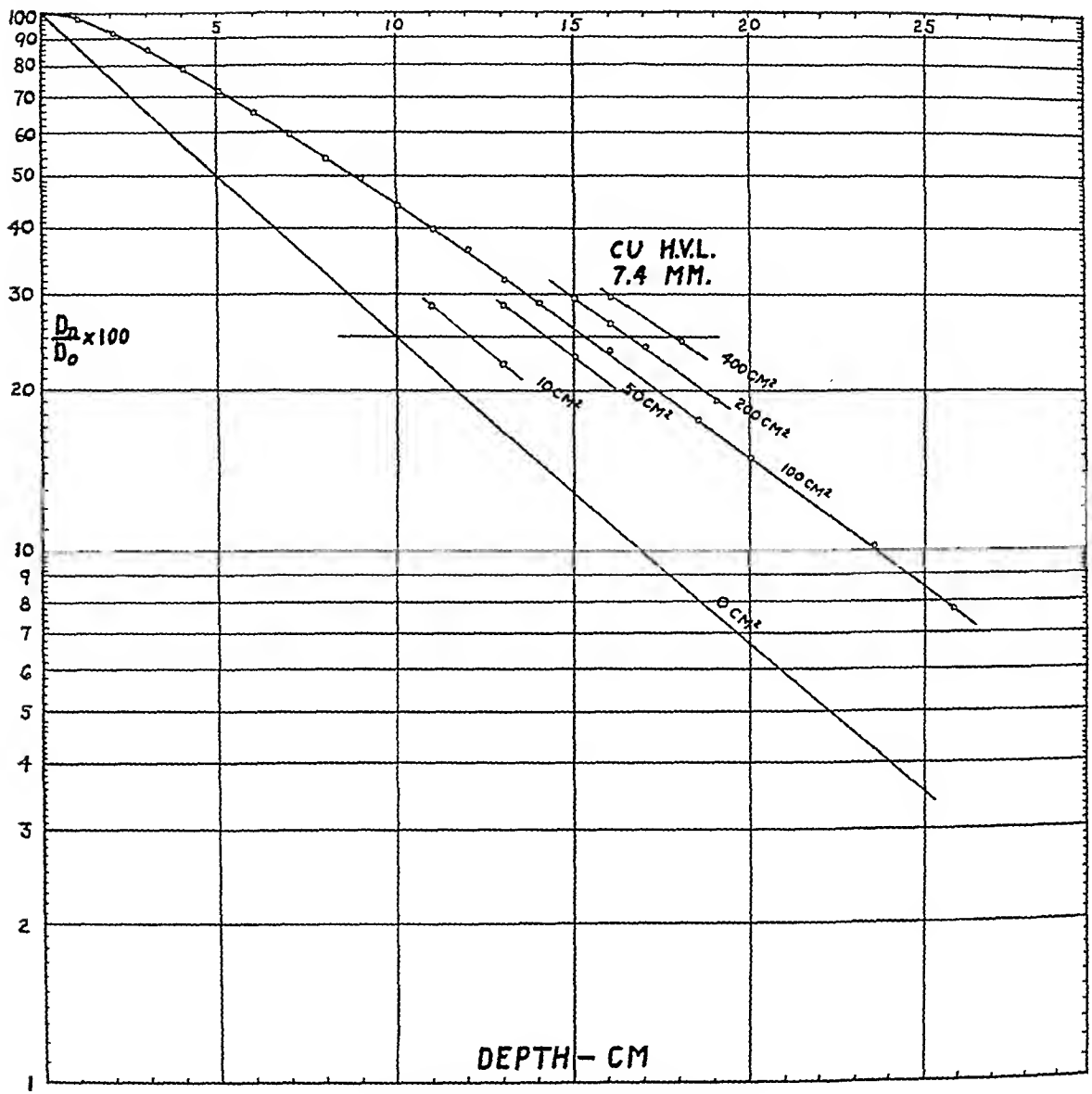


Fig. 9h.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

TABLE III: COMPARISON OF NARROW BEAM ABSORPTION COEFFICIENTS OF PRESWOOD AND WATER

Cu h.v.l. →	0.23 mm.	0.85 mm.	1.35 mm.	5.2 mm.
$\frac{\mu/\rho \text{ presdwood}}{\mu/\rho \text{ water}}$	0.90	0.93	0.85	0.95

$\mu/\rho$ -mass absorption coefficient. The ratios given for the last two h.v.l.'s may be wrong by as much as 5 per cent because the presdwood was not selected for average density.

urements were also made for beef muscle and for beef suet (fat tissue). The muscle was ground and packed into one of the containers used for the water transmission measurements as described in Part 3. The

suet was packed in the container with a little water to fill the spaces between pieces. The results of these tests with muscle and one with fat are shown in Table IV. The thickness given includes 1 mm. celluloid. The ratio of average linear absorption coefficients for tissue and water (line 4, Table IV) were obtained by comparison with the  $I/I_0$  curve for water at the same h.v.l. in Figure 8. The variation in the results for muscle may be due to the difficulty in packing the ground meat free from air spaces. In the first two trials it was packed under water; in the last without water. The values for suet have been cor-

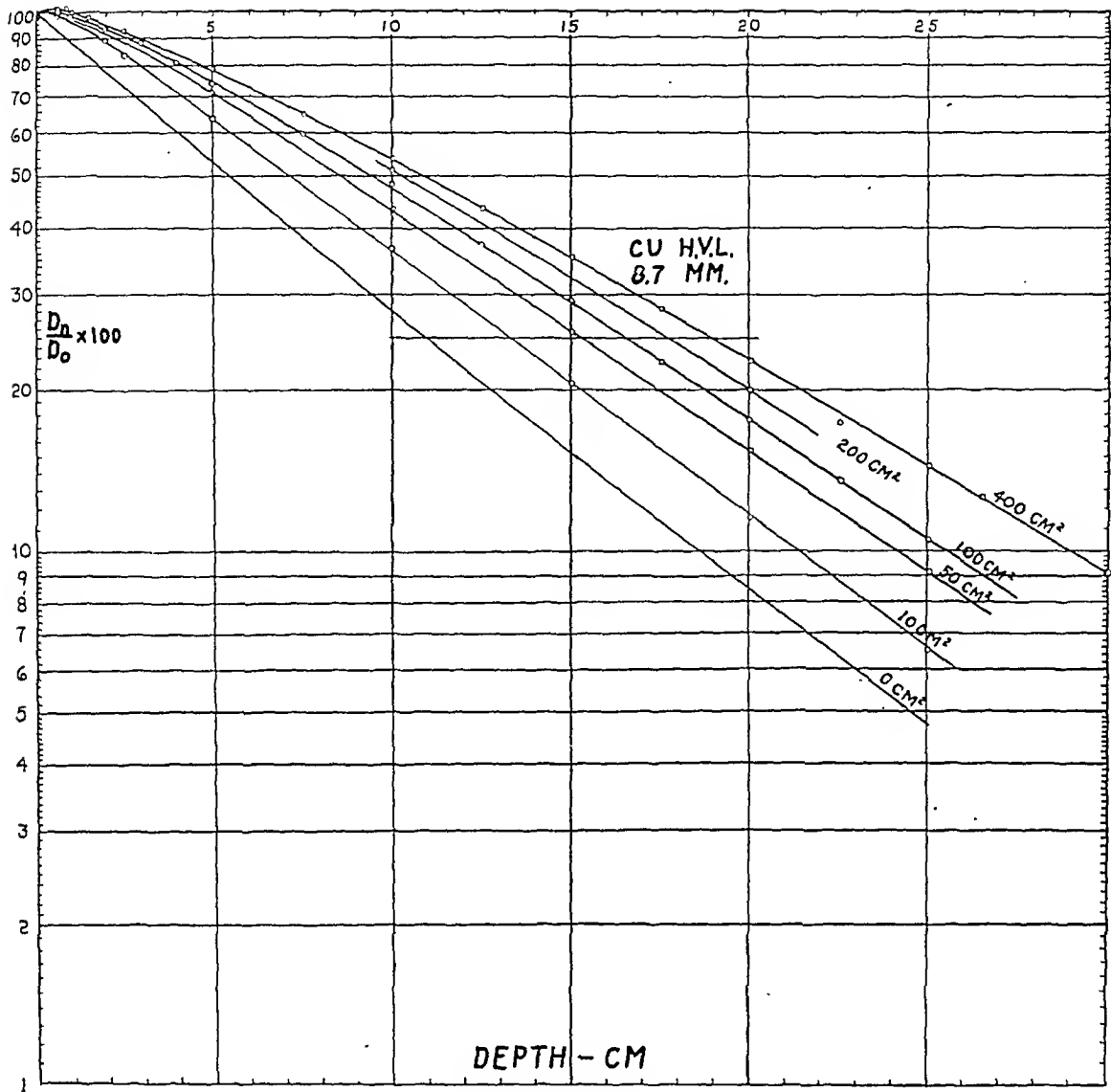


Fig. 9i.  $D_n/D_0$  ratios, 70.7 cm. f.s.d.

TABLE IV: NARROW BEAM TRANSMISSION MEASUREMENTS FOR BEEF TISSUE  
(Cu h.v.l. 0.23 mm.  $h = 2.2$ )

	Muscle			Suet
Thickness (cm.)	4.05	4.80	6.05	4.8
Density (gm./cm. <sup>3</sup> )	1.030	1.028	1.026	0.90
$I/I_0$	0.380	0.303	0.217	0.36
$\mu$ tissue				
$\mu$ water	0.97	1.00	1.04	0.87

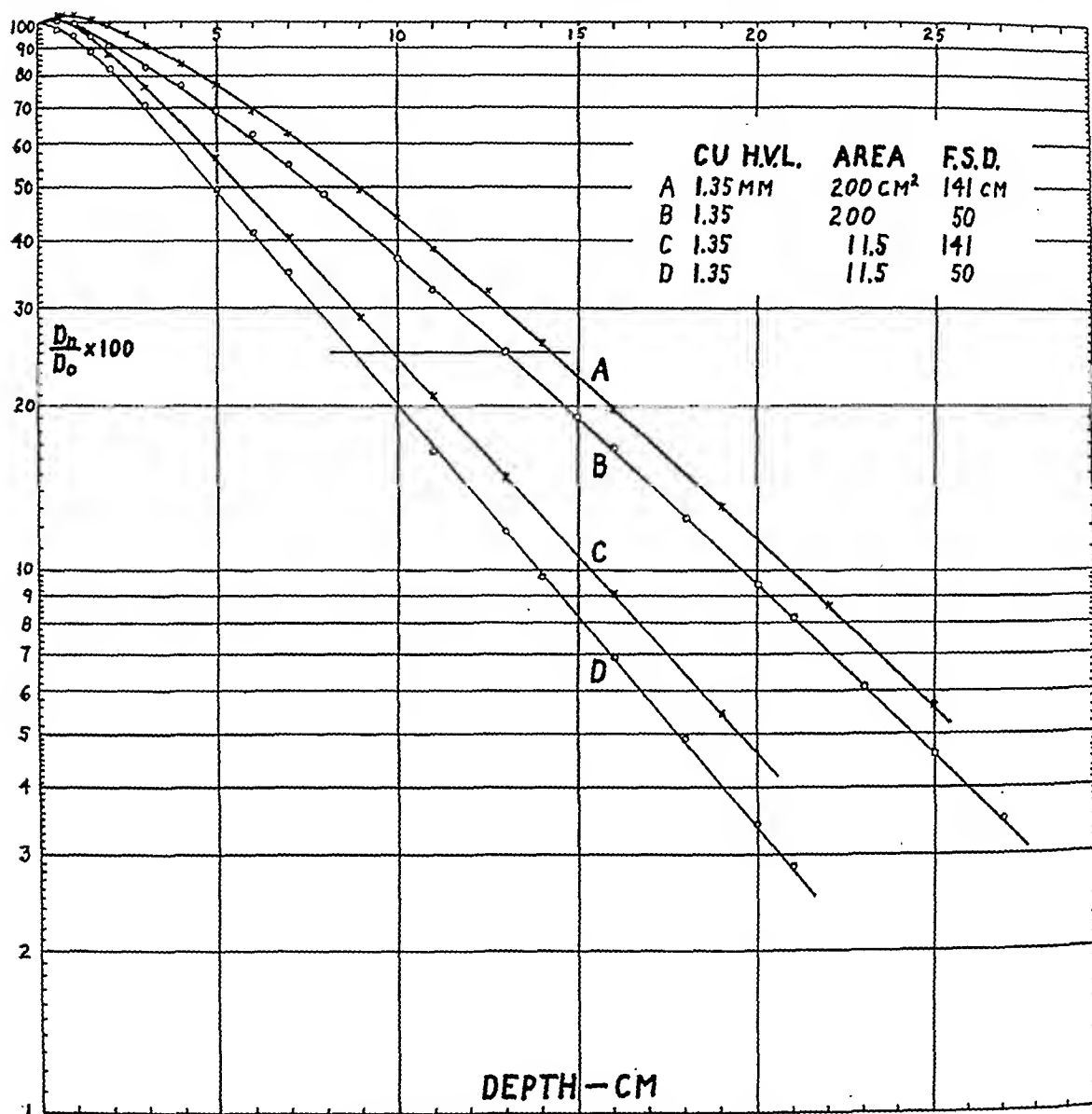
$I_0$  = initial intensity.  $I$  = transmitted intensity.  
 $\mu$  = linear absorption coefficient.

rected for 0.7 cm. water used to fill the spaces.  
A few exit intensities were measured with a special shallow water phantom hav-

ing a presdwood bottom 18 mm. thick. The chamber was held in a "half emerged" position in a close-fitting depression in the exit surface. The phantom was supported by the edges so that the exit beam had a clear path to the floor. Back-scatter from the floor was inappreciable. The exit intensities measured are given in Table VI and will be discussed in Part 5.

PART 5. DISCUSSION OF RESULTS

Experimental values of  $D_0/D$  and  $D_n/D_0$  ratios having been obtained as described in Part 4, the problem remained to present the information in a form suitable for con-

Fig. 9j.  $D_n/D_0$  ratios, 50 and 141 cm. f.s.d.

venient interpolation. A tabular method of presentation would have required an excessive amount of space. Furthermore, this method is poorly suited to exhibiting the orderly trends which are found in the data.

A method was devised to display all  $D_n/D_0$  ratios by means of a few charts. These charts, while unfamiliar in form, are extremely simple to use. Furthermore, they show at a glance the relationships between ratios for different sets of conditions.

The method employed in obtaining these charts from the curves of Figures 9a-k is based on the similarity in shape of the

curves, which appears when they are modified according to a simple procedure. This modification consists in adjusting the abscissa scale of each curve so as to make all the curves pass through an arbitrarily chosen point.

*Explanation of  $D_n/D_0$  Charts:* In Figures 9a-k the measured values of depth to surface ratio,  $D_n/D_0$ , are plotted against depth in centimeters on semilogarithmic rulings. It was discovered that, by suitable adjustment of the depth scale for each curve, all the  $D_n/D_0$  curves could be approximately superimposed on one another. For any one curve the adjustment con-

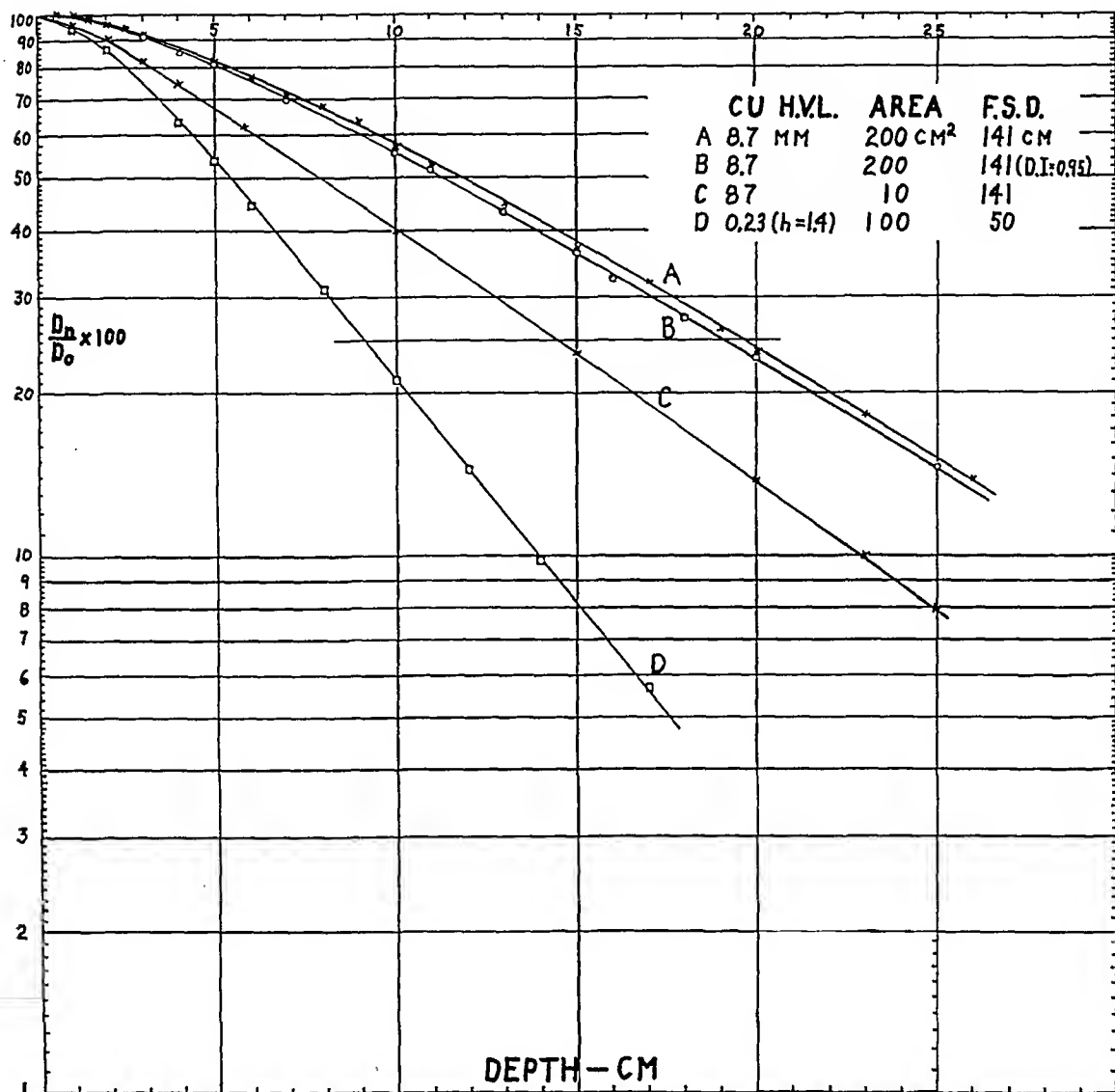


Fig. 9k.  $D_n/D_0$  ratios, 50 and 141 cm. f.s.d. Curve A: Divergence index 1.0. Curve B: Divergence index 0.95.

sisted in "shrinking" the abscissa of each point of the curve by a constant factor chosen so as to make the curve pass through the intersection of the rulings for 25 per cent and 5 cm. depth. The factor required for this adjustment of any curve will be called the "depth factor" for that curve. This procedure is illustrated in Figure 10 and further explained in the caption.

One curve from the midst of the group of "shrunk" curves was arbitrarily chosen as a "Standard  $D_n/D_0$  Curve." By "stretching" the Standard Curve in

accordance with the depth factor corresponding to any particular set of conditions, an approximate  $D_n/D_0$  curve can be obtained for those conditions.

To facilitate the process of shrinking and stretching the abscissa scale of  $D_n/D_0$  curves, a further modification has been made in the method of plotting the curves. This consists in altering the ordinate (percentage) scale in such a way as to change the Standard Curve into a straight line. The way in which this is done is shown in Figure 11.

From the straightened Standard Curve it



is a simple matter to get an approximate  $D_n/D_0$  curve for any set of conditions for which the depth factor is known. All that is necessary is to draw a straight line on Figure 13 from the upper left corner through the appropriate factor. From the

logarithmic rulings the plotted data fall close to straight lines. As explained previously, the field sizes employed were close to, but not exactly, even hundreds of square centimeters. Factors taken from Figure 14 for even values of field sizes are

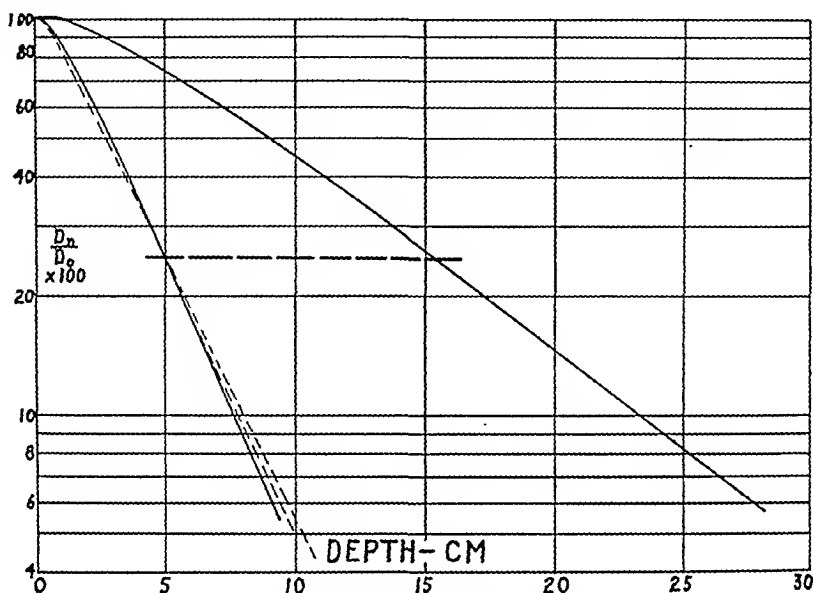


Fig. 10. Derivation of Standard  $D_n/D_0$  Curve.

The curve at the right is the  $D_n/D_0$  curve for h.v.l. 5.2 mm. Cu, area 200 cm.<sup>2</sup>, f.s.d. 70.7 cm., taken from Fig. 9. This curve crosses the 25 per cent line at 15.3 cm. depth.

Let the abscissa (depth) of each point of the curve be divided by a "depth factor"  $F = 15.3/5 = 3.06$ . A new curve will be obtained which will cross the 25 per cent line at 5 cm. This is the Standard Curve shown by the solid line at the left.

The factor by which any  $D_n/D_0$  curve must be shrunk to make it cross the 25 per cent line at 5 cm. will be called the "depth factor,"  $F$ , for that curve. The depth factor for any curve is the depth at which it crosses the 25 per cent line divided by 5.

Curves which have been shrunk in the way just described may be plotted along with the Standard Curve for comparison. The dotted curves in the figure represent  $D_n/D_0$  curves for 10 and 50 cm.<sup>2</sup> taken from Fig. 9 for the same h.v.l. and f.s.d. as curve A. The curves for 100 and 400 cm.<sup>2</sup> lie so close to the Standard Curve as to be indistinguishable.

The depth of 5 cm. was chosen for the intersection point in order that the Standard Curve should lie to the left of all the actual  $D_n/D_0$  curves, and so that all depth factors would be greater than unity. By making the curves cross at the 25 per cent level, the divergences between curves are about equally divided above and below this level for the range of depth measured. The divergences are very small at the depths of most clinical importance.

similar triangles which are thus formed, it is evident that this procedure corresponds to multiplying each abscissa of the Standard Curve by the same factor.

**Values of Depth Factors:** In Figure 14 the depth factors,  $F_{70}$ , for all the  $D_n/D_0$  curves measured at 70.7 cm. f.s.d. (see Fig. 9 a-i) are plotted against field area for all the h.v.l.'s employed in the measurements. It is seen that on double

plotted against half-value layer in Figure 15. Factors may be taken from either Figure 14 or 15 according to convenience.

For focal skin distances much different than 70 cm., a small correction in the depth factor  $F_{70}$  is required. For any focal skin distance the depth factor  $F$  can conveniently be given by multiplying the factor  $F_{70}$  by a correction factor  $F_d$ .

The way in which values of  $F_d$  were ob-

TABLE V: DEPTH FACTOR CORRECTION FOR FOCAL SKIN DISTANCE

h.v.l. mm. Cu	Field area cm. <sup>2</sup>	F <sub>d</sub> for 50 cm. f.s.d.	F <sub>d</sub> for 141 cm. f.s.d.
0.23 (h = 1.4)	0	0.96	...
	100	0.97	...
1.35	0	0.94	1.07
	11.5	0.92	1.03
	200	0.97	1.05
8.7	0	...	1.11
	10	...	1.08
	200	...	1.11

tained will now be explained. A few measurements were made of  $D_n/D_0$  ratios at 50 cm. and at 140 cm. These measurements, at three h.v.l.'s and three areas, are given in Figures 9j and k. For any h.v.l. and area and focal skin distance, the ratio of the depth factor  $F$  to the factor  $F_{70}$  for 70 cm. f.s.d. is the correction factor. Values of  $F_d$  obtained by comparison of the curves of Fig. 9j-k with the corresponding curves for 70 cm. f.s.d. are given in Table V. In the same table are shown values of  $F_d$  for zero area (primary beam). The values for zero area were obtained by combining the water transmission curve for each h.v.l. with inverse-square law for each f.s.d. This was done graphically, using tracing paper over semilogarithmic rulings.

By inspection of Table V it is seen that in only one case is the fractional difference between a measured value of  $F_d$  and the corresponding value for zero area as large as 4 per cent.

It is concluded that the values of  $F_d$  obtained for zero area may be used for all areas with sufficient accuracy for clinical purposes. Figure 16 gives values of  $F_d$  calculated graphically from the water transmission curves in Figure 8 for focal skin distances from 30 cm. to infinity. The values for infinity correspond to the transmission curves unmodified by inverse-square law.

Since our data for f.s.d.'s other than 70.7 cm. are rather few, we wished to check the validity of applying values of  $F_d$  obtained for zero area to finite field sizes. From the tables of Mayneord and Lamer-

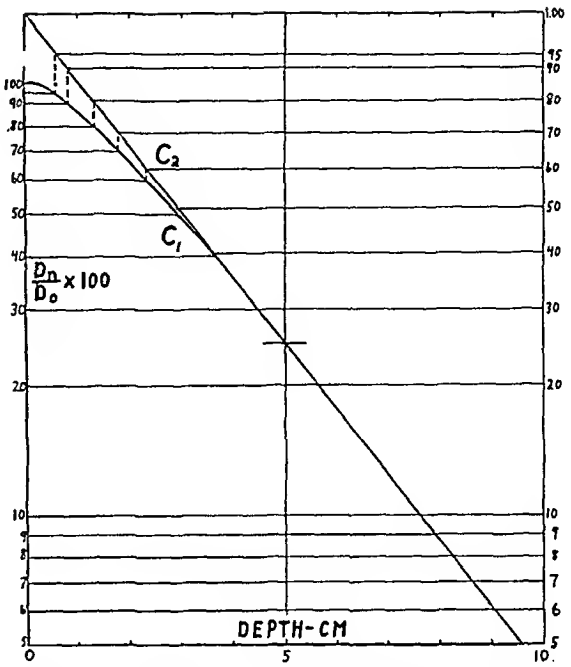


Fig. 11. Method of straightening the Standard  $D_n/D_0$  Curve. It is seen that the Standard Curve ( $C_1$ ) plotted on semilogarithmic rulings is very nearly straight in the portion of its length corresponding to percentages less than about 35 per cent. The straight portion is continued upward ( $C_2$ ) until it intersects the left-hand edge of the graph. This intersection is taken to represent 100  $D_n/D_0$  at the surface (zero depth). Horizontal lines representing 90 per cent, 80 per cent, 70 per cent, etc., are obtained by projecting  $C_1$  upward on  $C_2$  as shown.

The same  $D_n/D_0$  values will be obtained from either curve with its associated ordinate scale. For example, at 1.8 cm. either curve gives 70 per cent. It is evident that there is no significance attached to the particular choice of shrinking factor for establishing the Standard Curve. The new scale of ordinates for  $C_2$  could have been obtained just as well from the original curve before shrinking.

It is to be noticed that the straightened curve  $C_2$  is not able to represent the curve  $C_1$  at the beginning where the latter rises slightly above 100 per cent just below the surface. The ordinate scale is left blank over this part of  $C_2$ . For information about  $D_n/D_0$  ratios immediately below the surface, refer to the original data in Figs. 9a-k.

ton (5) we took  $D_n/D_0$  ratios for 50 and 100 cm. f.s.d., for fields of 0, 50, 100, 200, and 400 cm.<sup>2</sup> and for 1.5, 2.0, and 5.0 mm. Cu h.v.l. These ratios were then plotted on tracing paper over Figure 13. From the resulting curves, the ratio  $F_{50 \text{ cm.}}/F_{100 \text{ cm.}}$  was obtained for each h.v.l. and field size and compared with the corresponding ratios obtained from Figure 16. Surprisingly good agreement was found, there being no differences larger than 2 per cent.

*More Accurate Presentation of  $D_n/D_0$  Ratios:* The Standard Curve is only an approximate representation of most of the  $D_n/D_0$  curves of Figures 9a-k. While the approximation is accurate enough for most, if not all, clinical requirements, it seems desirable to show all the measured curves in relation to the Standard Curve. This is done in Figures 17a and b.

If a  $D_n/D_0$  curve is desired for a given set of conditions, the first step is to draw a straight line on Figure 13 for the appro-

expanding the abscissas, ordinate differences from Figures 17a and b may be transferred directly as corrections to an expanded curve drawn on Figure 13. This can be done with a pair of dividers or simply by eye.

The effect of non-homogeneity is illustrated by the curves of group b in Figure 17a. The dotted curve corresponds to a well filtered beam, while the other curves of the group are for a poorly filtered radiation.<sup>8</sup> It is to be noticed that the dotted

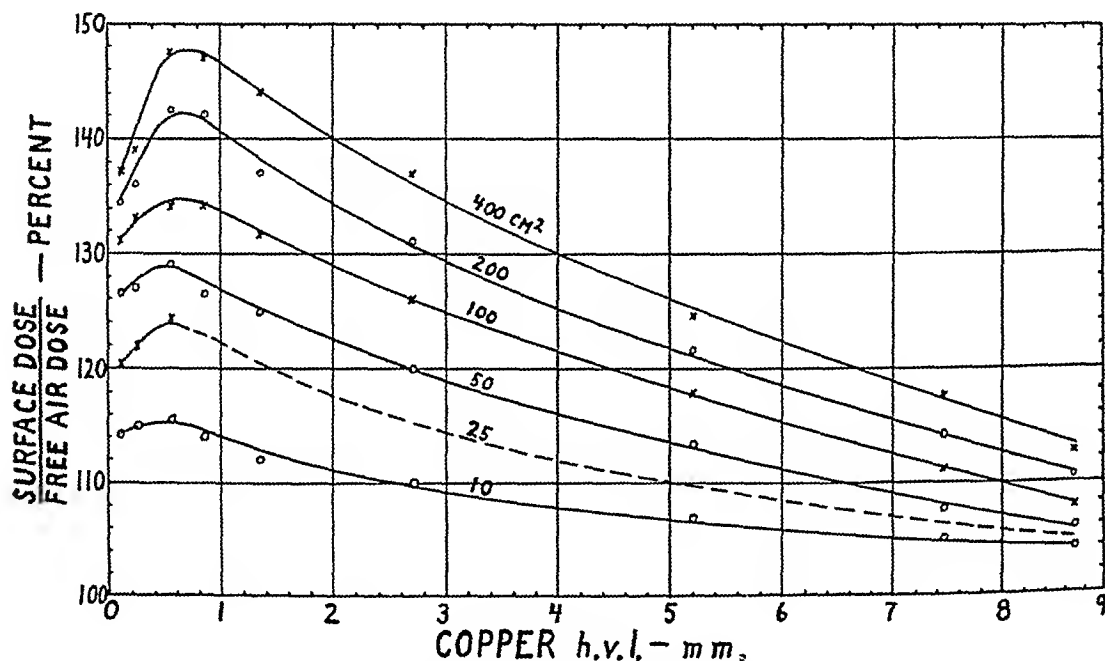


Fig. 12. Measured ratios of surface dose to free air dose. The actual field sizes corresponding to the round numbers shown on the chart were 10, 25, 49, 97, 190, and 385 cm.<sup>2</sup>

The reader may find it convenient to make a graph in which surface to air ratios shown here are plotted against field size for the h.v.l.'s which he customarily employs.

appropriate depth factor. This line is the expanded Standard Curve, and is an approximate  $D_n/D_0$  curve for the given conditions. The degree of approximation for the particular case can be seen at a glance in Figures 17a and b by referring to the curve which most nearly corresponds to the conditions in question. If the approximation is not so good as desired, the expanded Standard Curve can be redrawn in accordance with the appropriate curve in Figures 17a and b. This is easy to do, since the same ordinate scale is used in Figure 13 and Figures 17a and b. Since ordinates are unaffected by the process of shrinking or

curve and corresponding full line curve cross near the 25 per cent level, so that the "depth factors" are not greatly influenced by homogeneity, at least at low voltages, where homogeneity is less easily obtained with adequate output.

As explained in the preceding section, several  $D_n/D_0$  curves were plotted on Figure 13 using data from the tables of

<sup>8</sup> The lightly filtered beams used in therapy at voltages below about 100 kv. may be much less homogeneous even than those represented by solid lines in group b of Figure 17a. Dr. Edith Quimby has called our attention to curves for low-voltage therapy beams which differ in shape from ours by a considerable amount, but just in the manner to be expected from Figure 17a for their greater inhomogeneity.

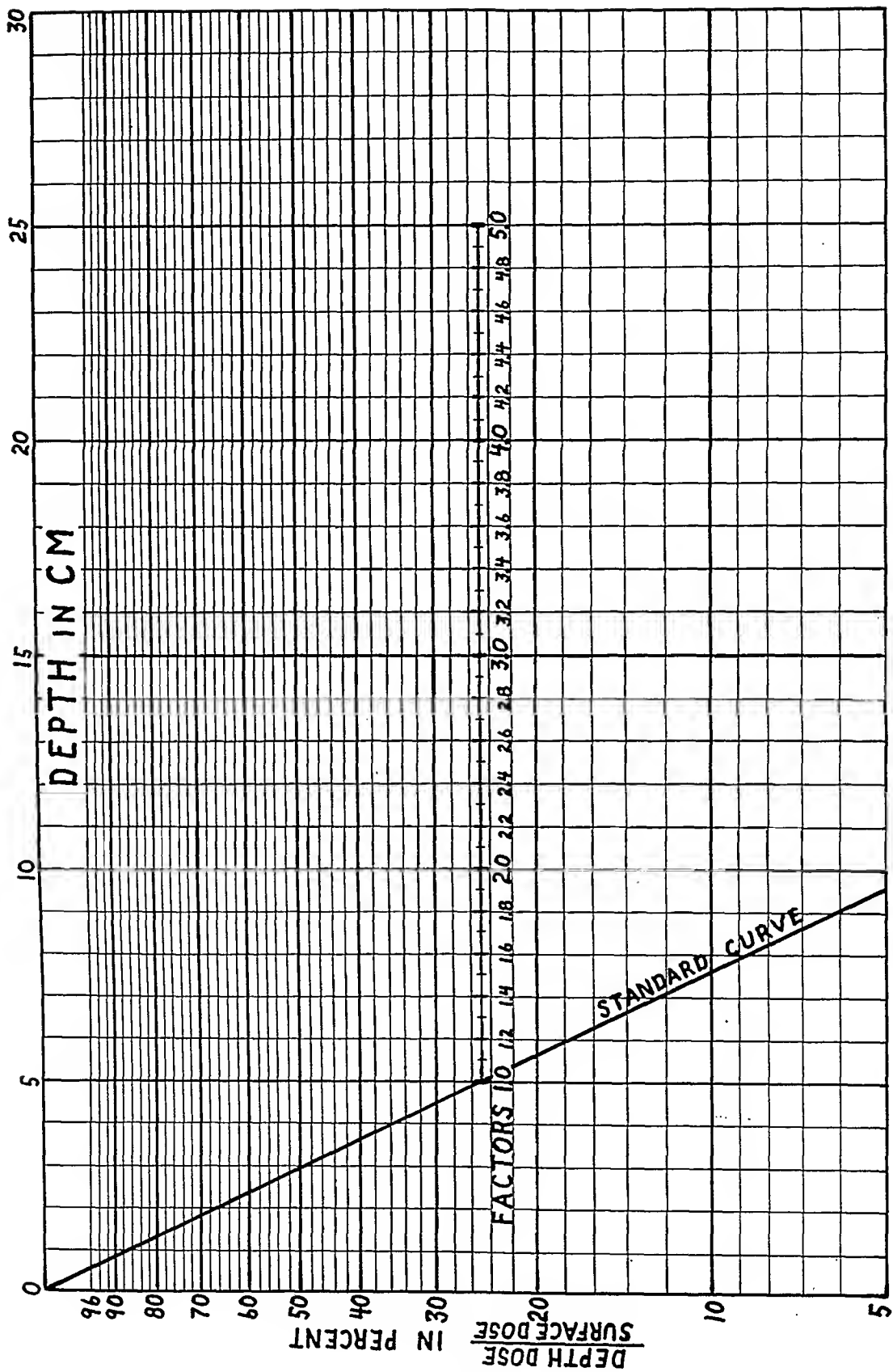
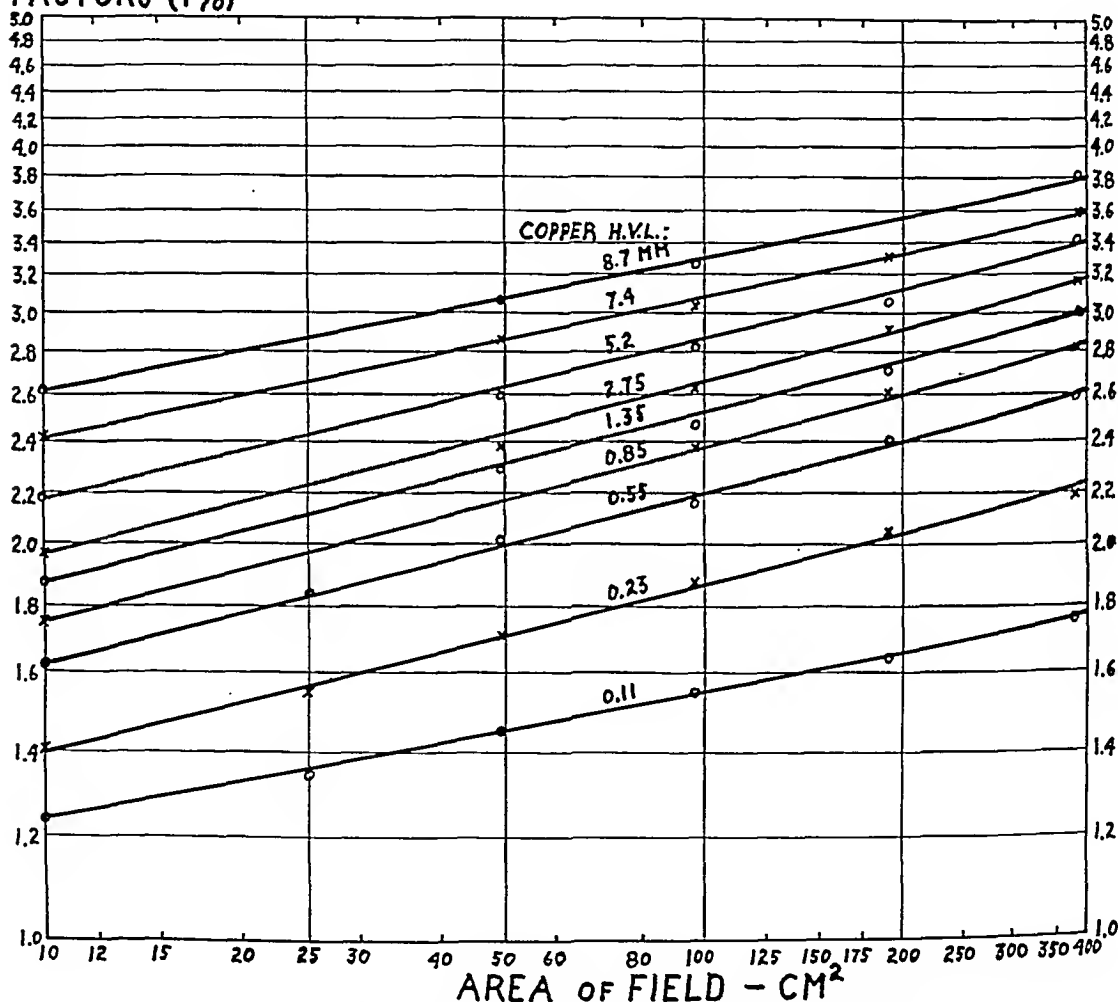


Fig. 13. Standard  $D_n/D_0$  curve (percentage depth dose).

TABLE VI: EXIT INTENSITIES

h.v.l. mm. Cu	Area, cm. <sup>2</sup>	Depth, cm.	D <sub>e</sub> (meas.), r/min.	D, r/min.	D <sub>n</sub> /D <sub>0</sub>	D <sub>e</sub> (calc.), r/min.	$\frac{D_e(\text{calc.})}{D_e(\text{meas.})}$
0.23 (h = 2.2)	200	13.9	5.6	45.4	0.136	6.2	1.10
0.55	100	12.1	6.82	34.7	0.215	7.45	1.09
	100	22.7	1.17	34.7	0.0375	1.30	1.11
7.4	200	17.5	9.95	46.7	0.227	10.6	1.06

D = free air dose.

D<sub>e</sub> (meas.) = measured value of exit dose. D<sub>e</sub> (calc.) = D · D<sub>n</sub>/D<sub>0</sub>.FACTORS (F<sub>70</sub>)Fig. 14. Factors F<sub>70</sub> plotted against area on double logarithmic rulings.

Mayneord and Lamerton (5). In most cases the D<sub>n</sub>/D<sub>0</sub> ratios of these authors agree with ours well enough to satisfy clinical requirements. However, for small field sizes and 20 cm. depth the values of Mayneord and Lamerton tend to be considerably larger than ours; in one case (5 mm. h.v.l., 100 cm. f.s.d.) by as much as

30 per cent (allowing for the correction to our Standard Curve obtained from Figure 17a).

It is gratifying that the values of D<sub>0</sub>/D (surface to free air ratios) given by Mayneord and Lamerton agree very closely with our results; the greatest fractional differences being around 3 per cent (e.g.,

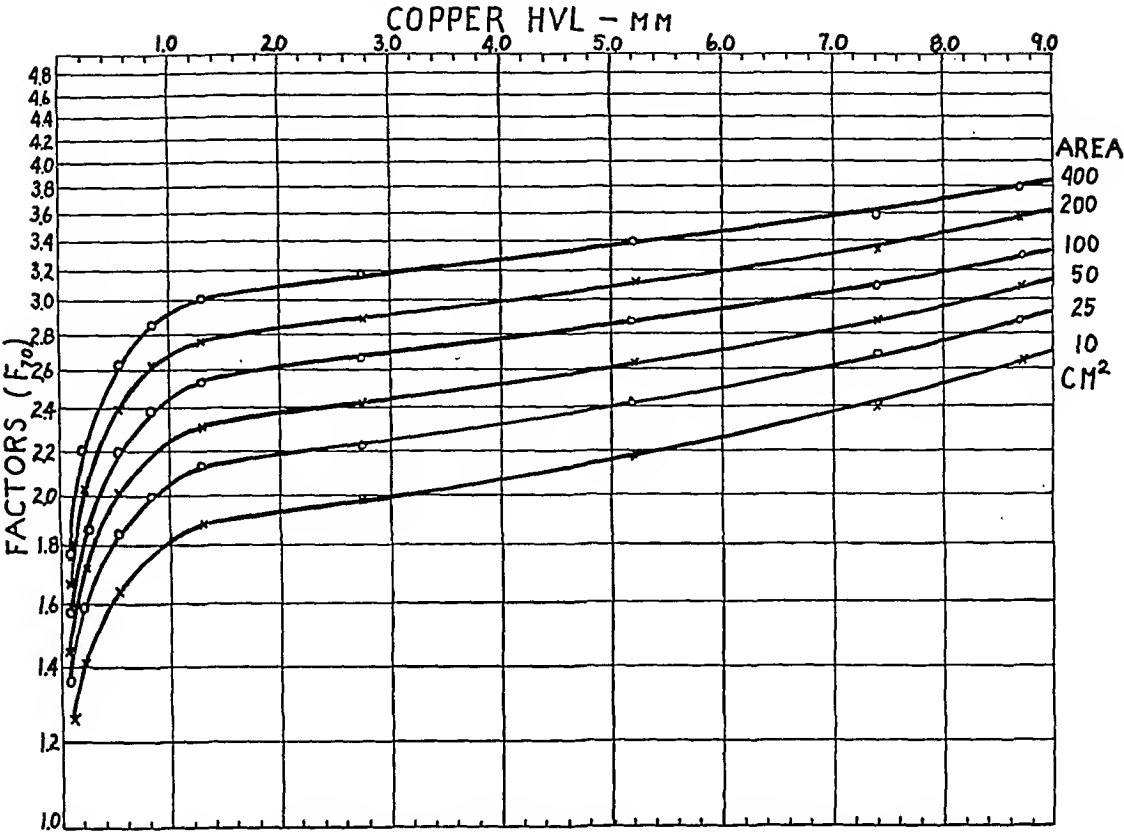


Fig. 15. Factors  $F_{70}$  plotted against copper h.v.l. on semilogarithmic rulings.

135 per cent compared to 131 per cent). Their values are nearly all on the low side as compared to ours. The surface to air ratios given by Quimby and others (14) likewise agree with ours within clinical accuracy, the largest fractional difference being 6 per cent on the high side for 0.3 mm. Cu h.v.l. and 400-cm.<sup>2</sup> area.

*Application of  $D_n/D_0$  Ratios to Exposures with Compression Cones:* If a layer of organic material is placed on the skin at the entrance portal, the upper surface becomes the effective zero depth. By reference to Figures 9a-k, it is seen that at depths of more than 2 or 3 cm. an error of 0.5 cm. in depth usually introduces a fractional error of from 5 to 10 per cent in the  $D_n/D_0$  ratio. This may be avoided by simply including the thickness of covering organic material in the depth.

The skin intensity under 0.5 cm. of covering material (as measured with a thick-walled chamber) may be taken as equal to the surface intensity within 1 or 2

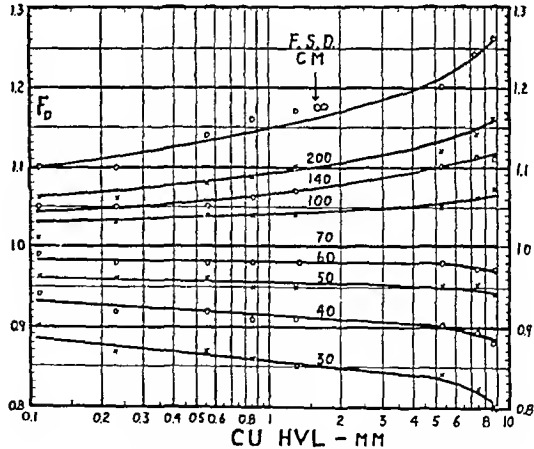


Fig. 16. Values of  $F_d$  calculated for zero area. (To be used for all areas.)

per cent, as may be seen from Figures 9a-k.

While, strictly speaking, the free air dose should be measured at the position of the upper surface of the layer of organic material rather than the skin, the effect of this refinement even at short focal skin distances would be little more than 2 per cent.

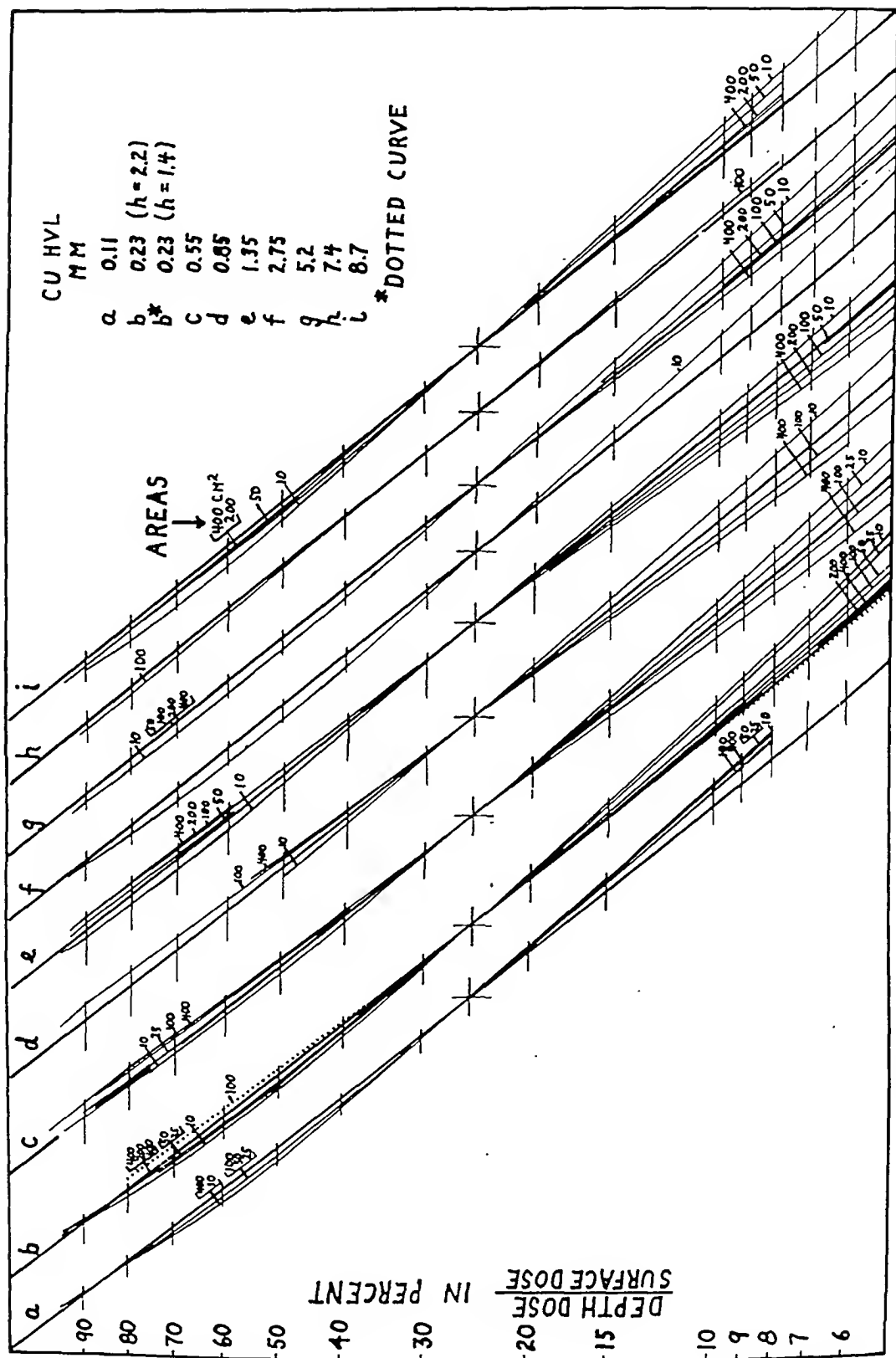


Fig. 17a.  $D_n/D_0$  curves compared with the standard curve (heavy straight line); f.s.d. 70.7 cm.

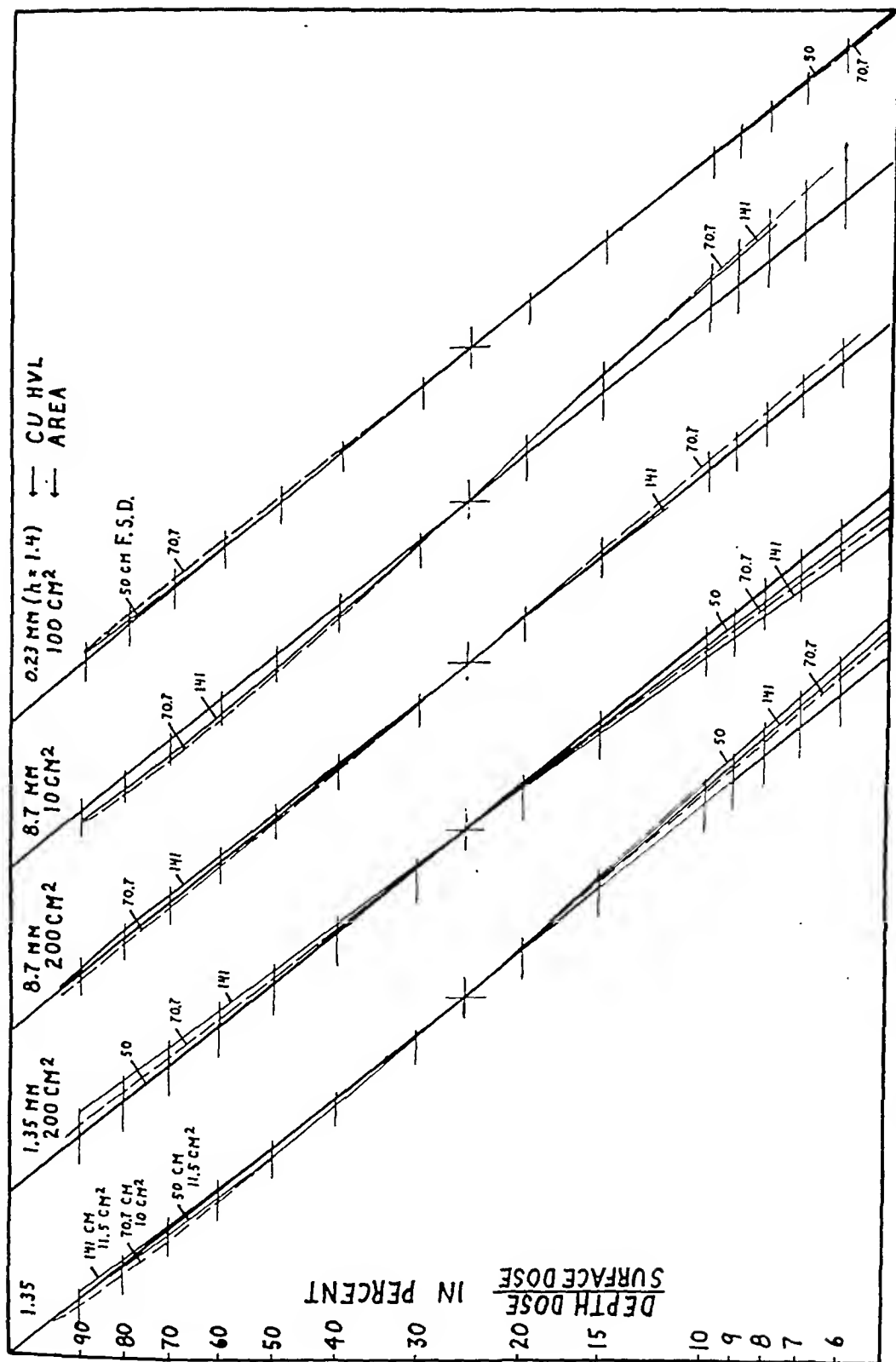


Fig. 17b.  $D_n/D_0$  curves compared with the standard curve (heavy straight line); f.s.d. 50 and 141 cm.



*Exit Doses:* Since the exit dose is usually small, a fractional error of even 10 per cent in its determination will introduce an error of only 1 or 2 per cent in the total cross-fire skin dose.

A few exit intensity measurements were described in Part 4, the results being given in Table VI. These measurements in conjunction with the following discussion suggest a simple procedure for getting exit doses with sufficient accuracy for clinical requirements.

In order to form an approximate picture of exit dose relationships, consider a beam of radiation in an infinitely deep phantom. Assume for the moment that at all depths the same fraction of the forward moving radiation (primary beam plus forward scatter) is scattered backward as at the surface. This amounts to saying that the forward moving radiation is the same fraction of the total intensity at all depths including the surface. Or, since the forward moving radiation at a given depth may be taken as the exit intensity:

$$D_e/D_n = D/D_0.$$

Hence:

$$D_e = (D/D_0) \cdot D_n = D \cdot (D_n/D_0).$$

*Or, the exit dose is equal to the free air dose multiplied by the depth to surface ratio.*

The relation just derived will not be expected to hold very closely, since the fraction of radiation scattered back is certainly not the same at all depths, as was assumed. However, all the exit doses calculated in this way, and shown in Table VI, are in error on the "safe side," from a

clinical standpoint, being 6 to 11 per cent larger than the corresponding measured values.

*Depth Factor as an Index of Penetration:* Referring to Figure 13, it is seen that the depth factor for any beam is proportional to the depth at which a  $D_n/D_0$  ratio (percentage depth dose) of 25 per cent is obtained. To the degree of approximation to which the actual  $D_n/D_0$  curves are represented by the Standard Curve (see Figures 17a and b), the same statement applies for all  $D_n/D_0$  ratios. Thus the depth factor is a convenient measure of the "penetration" of a beam, and the ratio of the depth factors of two beams is an index of their relative penetration. The relation of penetration to h.v.l., field size, and f.s.d. may be studied in Figures 14, 15, and 16.

Inspection of Figure 14 shows that improvement in penetration with increasing h.v.l. is not limited to small field sizes. For example, in going from 1.35 to 8.7 mm. h.v.l. the depth factor increases by 33 per cent for 50-cm.<sup>2</sup> and 27 per cent for 400-cm.<sup>2</sup> fields.

It is of interest to compare the depth factors obtained from Figure 15 for three beams of 100-cm.<sup>2</sup> area: (a) 200 kv., 0.5 mm. Cu filter, 1 mm. Cu h.v.l.; (b) 400 kv., 2 mm. Cu filter, 4 mm. Cu h.v.l.; (c) 1,000 kv., 9 mm. Cu h.v.l. The corresponding depth factors are 2.45, 2.77, and 3.33. It is seen that the 400-kv. beam has 13 per cent and the 1,000-kv. beam 36 per cent more penetration than the 200-kv. beam.

Arrangements have been made to furnish at cost positive photostats (black lines on white) of the original drawings for Figures 12, 13, 14, 15, 16, 17a and b. Figure 13, for example, is 9 in.  $\times$  14 in. The set may be had by sending \$2.00 to H. A. Rogers Co., 815 Marquette Ave., Minneapolis 2, Minn. Extra copies of Figure 13 may be had for \$0.35 each. One or two of these may be useful as work sheets in preparing dosage tables for the reader's customary treatment conditions. Or the appropriate lines drawn on Figure 13 may be used in place of percentage depth dose tables.

A copy of the *Summarized Instructions for Using Dosage Charts*, appearing on page 399, will be furnished with the charts.

### *Summarized Instructions for Using Dosage Charts*

It is desired to find surface intensity,  $D_0$ , depth intensity,  $D_n$ , and exit intensity,  $D_e$ , for given values of half-value layer, field size, and focal skin distance.

These results, for points on the axis of the beam (center of field), are obtained in the following steps:

1. Measure the free air intensity,  $D$ , in r/min. at the point corresponding to the center of the skin field (e.g., 20 r/min.).

2. From Figure 12 find the value of the "Surface to Air Ratio"  $D_0/D$ , for the given h.v.l. and field size. Multiply  $D_0/D$  by  $D$  to get the surface intensity,  $D_0$  (e.g., 125 per cent of 20 r/min. = 25 r/min.).

3. In step 4, a "depth factor,"  $F$ , will be required. From Figure 14 or 15 find the factor  $F_{70}$ , which is the desired depth factor in cases where the focal skin distance is 70 cm.

In case the f.s.d. is larger or smaller than 70 cm., obtain a correction factor,  $F_D$ , from Figure 16. Multiply  $F_{70}$  by  $F_D$  to get the depth factor  $F$ .

4. On Figure 13 draw a straight line from the upper left-hand corner through the point on the 25 per cent line corresponding to the depth factor,  $F$ , just obtained.

The straight line thus drawn will be an approximate  $D_n/D_0$  (percentage depth dose) curve for the given conditions.

The depth intensity,  $D_n$ , for any desired depth may be obtained by multiplying the  $D_n/D_0$  ratio for that depth by the value of  $D_0$  obtained in step 2 (e.g., 20 per cent of 25 r/min. = 5 r/min.).

5. The special ordinate scale of Figure 13 was chosen so that the straight line

(Standard)  $D_n/D_0$  curves would approximate the actual curves closely enough for clinical requirements, except possibly in some cases for the smallest field sizes (around 10 cm.<sup>2</sup>).

The degree of approximation can be seen in any particular case by examining curves in Figures 17a and b for conditions similar to those under consideration. If desired, the straight line curve drawn in Figure 13 can be corrected by transferring to it the ordinate deviations found in an appropriate curve in Figures 17a and b. This is easily done with a pair of dividers, or simply by eye, since the same ordinate scale is used in Figures 13 and 17, and since ordinate relations are unaffected by the different abscissa scales.

6. If the skin is covered with a layer of organic material, the thickness of this layer should be added to depths below the skin surface. The skin dose will be practically unaffected by the additional material. (This last statement refers to x-ray dosage in roentgens and does not exclude the possibility of an appreciable effect of the surface layer on secondary electron equilibrium with high-voltage radiation.)

7. To get an approximate value of the exit intensity, simply multiply the  $D_n/D_0$  ratio for the depth of the exit surface by the free air intensity,  $D$  (e.g., 20 per cent of 20 r/min. = 4 r/min.). It appears that exit doses obtained in this way are likely to be from 5 to 10 per cent higher than actual values. Since the exit dose is usually only a small part of the total cross-fire dose, this error, which is on the "safe" side, is of no importance.

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ACKNOWLEDGMENTS: The work which has been described was begun and carried on for several years under the direction of Professor Francis C. Wood. It is a special pleasure to express our thanks to him, both for his valuable suggestions and continuing interest and for his unfailing support in the task of developing a generator suitable for experiments of this type. We are grateful to the Markle Founda-

tion for financial support during a part of this investigation. For generous cooperation in connection with the development of the Sloan x-ray generator, we are indebted to Professor E. O. Lawrence, Dr. D. H. Sloan, the Research Corporation, the Chemical Foundation, and the Allegheny Steel Company. The General Electric Company cooperated by designing special power supply equip-

ment. The Columbia Presbyterian Hospital furnished convenient quarters for housing the x-ray generator and laboratory. Among individuals too numerous to list who helped in the construction of the generator, we wish especially to mention the late Dr. Wesley Coates, Mr. Arthur Chick, Mr. Darrow Haagensen, Mr. E. E. Gyana, Mr. Frank Matthews, and Mr. George Roch.

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# EDITORIAL

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## Radiology and Physics

Advancing radiological technique brings with it problems of organisation and human relationships. An important example arises in radiation therapy, where the closest collaboration between radiologist and physicist is now recognised to be essential; yet even to most physicists the problems appear strange and bewildering, and it is scarcely surprising that medical radiologists find increasing difficulty in following the detailed mathematical and physical studies of the techniques which are now emerging.

We may take the view that the medical man has so many problems of his own that it is quite impossible and undesirable for him to attempt to follow these details, and similarly the physicist may find what is to the radiologist the most elementary anatomy and pathology a maze of hopeless sounds. Unless the medical radiologist understands something at least of the power and limitation of the physical methods, he will certainly not be able to make best use of his physical colleagues, who in their turn will be unable to make relevant suggestions of alteration in technique or criticisms of present procedures unless at least superficially acquainted with the medical radiologist's mode of speech.

One of the most efficient ways of bringing together these two groups of people with divergent methods of training, and therefore outlook, lies in the physicist attending regularly at radiological clinics and seeing there the difference between a neat diagram of radiation fields and cancer in its most unmathematical forms. The radiologist on his part will find regular visits to an experimental laboratory stimulating and perhaps chastening experiences.

A good deal might be done to relieve

the situation by a more systematic training of the hospital physicist. Frequently even a change in mathematical approach to a problem will make collaboration much easier. For example, it will be found in studying radiation distributions that the medical radiologist will visualize results much more clearly if the physicist avoids formal mathematical analysis, substituting geometrical methods. A formula is anathema, but the shape of an isodose surface is almost anatomy. The physicist, too, is apt to think his job is done when he states, let us say, "that for a length of 2.7 cm. the dose in a certain plane does not fall below 90 per cent." Such a statement means little to most medical radiologists, but expressed in the form that "the 90 per cent isodose surface stretches anteriorly from the lower border of the hyoid bone to the upper border of the cricoid cartilage" instantly brings a look of relief and gratitude. This method of approach implies that the hospital physicist should be instructed in elementary anatomy, so as to be able to take a more intelligent interest in the parts of the body he helps to treat, as well as to be able to transmit his hard-won information in a more acceptable form to his medical colleagues. The anatomy taught to the physicist should of necessity be of rather a special variety, which we might describe as "geometrical anatomy." Size, shape, and position are of more importance to him than structure or function, which clearly lie outside his province.

It must be emphasized that the correct physical approach to a therapeutic problem lies in the recognition of the paramount importance of the tumour dose in roentgens. One cannot help feeling, look-

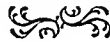
ing at the present-day techniques, that we are still hypnotised by the skin. From a physical point of view the rational way of planning a treatment is to decide the shape and extent of the volume which we wish to treat and deduce from this information the size and shapes of the fields we should employ on the surface. So far, little work of this kind has been done, and how far it may prove possible in practice we do not yet know, but it seems, from the physical point of view, the right way of beginning. Moreover, the treatment should be planned before it commences, and the physical investigations be more than a postmortem study of the errors we have made.

It has usually been thought that too close a reliance on physical methods leads to cast-iron techniques and standardised dosage. This is indeed a grave error, and the reverse is more nearly true. There can be no doubt that variation of size and condition from patient to patient is of the utmost importance, and the standardisation of technique is becoming increasingly indefensible, since the detailed physical studies now provide the necessary information to enable adjustment of technique from patient to patient to be made on a rational basis. Such

physical studies tend towards flexibility rather than standardisation. This is an important lesson for both radiologist and physicist to learn, and they are more likely to learn together than separately.

Only the closest personal collaboration of radiologist and physicist, only the daily discussion of mutual problems, only the realisation that the medical man has final responsibility but the physicist an indispensable interest, can solve the problem of one of the most important applications of science in medicine. The physicist must realise that, however fascinating and important his more academic problems, his primary responsibility in this respect is to be useful, while on the part of the medical radiologist we should ask for a more enlightened understanding of the importance of the physicist not only in solving the technical day to day problems, but also as a spearhead of the attack on the fundamental biophysical problems of the structure of living material and its interaction with radiation.

W. V. MAYNEORD  
*Physics Department*  
*The Royal Cancer Hospital (Free)*  
*London*



## CLEVELAND RADIOLOGICAL SOCIETY

In commemoration of the semicentennial anniversary of Roentgen's discovery of x-rays, exhibits and lectures are being jointly planned by the Cleveland Radiological Society and the Museum of the Cleveland Medical Library. Dr. Otto Glasser, eminent Cleveland physicist and friend of Roentgen, is conducting the arrangements.

Current officers of the Cleveland Radiological Society are John O. Newton, M.D., President; J. Robert Andrews, M.D., Vice-President; Don D. Brannan, M.D., Secretary-Treasurer.

## DENVER RADIOLOGICAL CLUB

At a recent meeting of the Denver Radiological Club, Dr. George Unfug of Pueblo was elected President; Dr. John H. Jamison of Denver was elected Vice-President; Dr. Leonard G. Crosby and Dr. A. Page Jackson, Jr., were re-elected Treasurer and Secretary, respectively.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

The next meeting of the Pennsylvania Radiological Society will be held May 5 and 6, at the William Penn Hotel, Pittsburgh.

## CANCER TEACHING DAY

A Cancer Teaching Day program will be presented at the Hotel Statler, Buffalo, N. Y., on April 26, under the auspices of the Erie County Medical Society, the Buffalo Academy of Medicine, the Medical Society of the State of New York, the University of Buffalo School of Medicine, and the Division of Cancer Control of the New York State Department of Health.

The speakers will be Dr. Donald Guthrie on "Diagnosis and Surgical Treatment of Carcinoma of the Breast;" Dr. Lloyd F. Craver on "What Can the General Practitioner Do About Lowering Cancer Mortality?" Dr. Hayes Martin on "The Diagnosis and Curability of Intraoral Cancer;" Dr. John H. Garlock on "Carcinoma of the Colon."

## Letter to the Editor

Dear Sir:

It is with sincere pleasure that we have noticed and welcomed the regular attendances of an increasing number of U.S.A.M.C. roentgenologists at the scientific meetings of our three Radiological Societies—the British Institute of Radiology, the Faculty of Radiologists, and the Section of Radiology of the Royal Society of Medicine.

Usually, the three Societies hold their meetings on

the third Thursdays and Fridays in each month, in London.

We write as the Presidents of the three Societies to express the appreciation we have all felt of the interest shown and of the part played in discussion by our American radiological colleagues, and to say that their continued attendances will be warmly welcomed whilst they remain in Britain. Many of us wish that we could have offered more private hospitality, but this has been difficult to achieve because of numerous wartime restrictions.

Our American visitors have undoubtedly helped towards the continued success of our meetings, which are by no means easy to arrange because of the extreme pressure of work on radiologists at the present time, and secondarily because of travelling difficulties.

We remain,

Yours sincerely,

ROHAN WILLIAMS

(British Institute of Radiology)

RALSTON PATERSON

(Faculty of Radiologists)

J. L. GROUT

(Section of Radiology, Royal Society of Medicine)

*Post-script:* Full information may be obtained from the Secretaries at:

British Institute of Radiology, 32, Welbeck Street, London. W.1.

Faculty of Radiologists, 45, Lincoln's Inn Fields, London. W.C.

Section of Radiology, Royal Society of Medicine, 1, Wimpole Street, London. W.1.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**SUPER-VOLTAGE X-RAY THERAPY. A REPORT FOR THE YEARS 1937-1942 ON THE MOZELLE SASSOON SUPERVOLTAGE X-RAY THERAPY DEPARTMENT, ST. BARTHOLOMEW'S HOSPITAL.** By RALPH PHILLIPS, M.S., M.B., F.R.C.S., D.M. R.E., Sir Halley Stewart Fellow, with the technical assistance of G. S. INNES, B.Sc., A.M.I.E.E., Physicist to the Mozelle Sassoon Department. With a Foreword by The Rt. Hon. The Lord Horder, G.C.V.O., M.D., F.R.C.P. A volume of 142 pages, with 95 illustrations. Published for The Sir Halley Stewart Trust by H. K. Lewis & Co., Ltd., London, 1944. Price 16s. net.



VERNOR M. MOORE, M.D.  
1886-1944

## In Memoriam

VERNOR M. MOORE, M.D.  
1886-1944

Vernor M. Moore, a member of the Radiological Society of North America since 1919, died at his home in Grand Rapids, Mich., Dec. 30, 1944, after a brief illness.

Doctor Moore was born in Freeport, Mich., Feb. 10, 1886. He received his preliminary education at Olivet College and was graduated in medicine from the University of Michigan in 1911. Soon after his graduation he located in Grand Rapids, where he was associated with the late Dr. Richard R. Smith. Doctor Moore's interest in roentgenology led him to devote his entire time to that specialty, and he opened his own offices in 1918.

Doctor Moore led an active life and had a large practice. He was particularly interested in radiation therapy and in chest lesions. That his professional colleagues appreciated his efforts and interest in medicine is indicated by the high regard

in which he was held and the important offices he filled in his local and state medical societies. He served as Councilor for the Michigan State Medical Society for ten years, and at the time of his death was President-Elect of the State Medical Society. He was Past-President of the Kent County Medical Society and the Michigan Association of Roentgenologists. He was much interested in anti-tuberculosis activities and was a member of the Board of Directors of his local Anti-Tuberculosis Society for several terms. In addition to membership in the Radiological Society of North America, Doctor Moore was a member of the American Roentgen Ray Society and a diplomate of the American Board of Radiology.

Doctor Moore was a congenial host, and a visit with the Moore family was an event to be eagerly anticipated and recalled with pleasure. His many friends in the medical profession will be grieved to learn of his untimely death. He is survived by his wife, three sons, and a daughter. One of the sons, Gordon, is in military service abroad.

E. R. WITWER, M.D.





# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic; Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer, Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*St. Louis Society of Radiologists.*—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Non-Secreting Cysts of the Maxillary Sinuses, with Special Reference to the Roentgen Aspects and Diagnosis of the Large Types.** Jack W. Grossman and Harold D. Waltz. *Am. J. Roentgenol.* 52: 136-144, August 1944.

In a series of 80 consecutive roentgen examinations of the sinuses, 13 cases of probable antral cysts were found. Six of these were of the non-secreting type, filling the entire antrum.

The classification of cysts of the maxillary sinus given by Lindsay (*Laryngoscope* 52: 84, 1942) is quoted, as follows:

1. Benign cysts arising from the jaw or teeth
  - (a) Follicular (dentigerous) cyst
  - (b) Radicular (root cyst, dental cyst)
  - (c) Median anterior maxillary cyst
2. Benign cysts arising from the sinus mucosa
  - (a) Secreting cysts
    - Gland or mucous cysts
    - Mucocele
  - (b) Non-secreting cysts of sinus mucosa

Of these various types, the most common is the non-secreting cyst. This varies in size and location but tends eventually to gravitate downward to the most dependent portion of the antrum. It arises in the sub-epithelial connective tissue as a result of fluid retention in the connective-tissue spaces. It probably is caused by the action of bacterial toxins resulting from infection producing damage of the capillary walls and altering their permeability.

Diagnosis is dependent largely upon roentgen examination, since clinical signs and symptoms may be absent and there may be little interference with transillumination. Small cysts are readily recognized by the contrast afforded by the air around them. They differ from polyps in that the lining membrane is usually normal. Large cysts may cause complete opacity of the antrum. Of significance in diagnosis is the fact that the shadow does not change in the upright and recumbent projections. Also, there is no alteration in the bony wall to indicate infection, pressure atrophy, or invasion. These findings aid in differentiation between large cysts and acute inflammatory lesions, polyps, mucocele, and carcinoma. The absence of significant clinical symptoms (except toothache when the cyst is under pressure) and the knowledge that the sinus transilluminates well make the diagnosis more certain.

L. W. PAUL, M.D.

**Hyperparathyroidism, with Failure to Recalcify After Removal of Parathyroid Adenoma (A Case Report).** Charles P. Voltz and Katharine Smull. *Ann. Int. Med.* 21: 329-332, August 1944.

A parathyroid adenoma was removed from a patient with a history of repeated pathological fractures and roentgen evidence of generalized skeletal decalcification associated with cystic and fibrotic bone changes. Five years later the roentgen picture of decalcification was unchanged, in spite of the fact that there was no evidence of recurrent hyperparathyroidism. The authors attribute this to arrested osteoblastic activity.

## THE CHEST

**The Blood Supply of the Sternum. I. X-Ray Studies of Injected Sternums Showing Venous Return.** Philip Pizzolato. *New Orleans M. & S. J.* 97: 71-72, August 1944.

Investigations of the blood supply of the sternum were carried out with 5 per cent ferric ferrocyanide and lead chromate as blue and yellow pigments, in a 20 per cent vinylite solution in acetone. The former is excellent for translucent preparations, while the latter is more opaque to the x-rays. In these studies, 1 to 5 c.c. of the mixture was injected in the manubrium and in various portions of the body of the sternum. The medium flowed with slight difficulty and soon entered the sternal tributaries of the mammary vein. The bones were x-rayed and then cleared in oil of wintergreen. The author found no sternum in which large blood vessels ran through the body, as reported by Tocantins (*Proc. Soc. Exper. Biol. & Med.* 45: 292, 1940); in the adult he observed a few large branches anastomosing at the lower portion of the sternum, and in children, small branches connecting one center of ossification with another.

**Agenesis of the Lung.** Anibal Roberto Valle and Evarts A. Graham. *J. Thoracic Surg.* 13: 345-356, August 1944.

A review of the literature shows 38 proved cases of agenesis of the lung. All of these cases are abstracted briefly in tabular form, and 2 additional examples are presented. One of the patients, a forty-one-year-old woman, was explored and the diagnosis verified. In the second patient, a five-year-old boy, the diagnosis was not proved. In each case it was the left lung which was absent, an observation which is twice as common as absence of the right lung. The x-rays showed a uniform opacity of the left lung field with a high diaphragm, shift of the mediastinum to the left, and narrowed intercostal spaces. Bronchography revealed a short left main bronchus with complete occlusion. Bronchoscopy showed the bronchus to end abruptly with a smooth mucosa and no suggestion of a tumor.

There are usually no acutely distressing symptoms in agenesis of the lung, but dyspnea, cyanosis, and harsh breathing are common, and young patients do not develop as well or as rapidly as normal children.

[Deweese and Howard (*Radiology* 42: 389, April 1944) were able to find in the literature 43 cases of congenital absence of the lung, to which they added another.—Ed.] H. O. PETERSON, M.D.

**Closed Intrapleural Pneumonolysis.** C. G. Bayliss. *M. J. Australia* 2: 129-137, Aug. 5, 1944.

The suitability of a patient for intrapleural pneumonolysis rests primarily on the roentgen examination, supplemented by fluoroscopic observation. In the author's experience, the preoperative opinion that a patient was unsuitable for pneumonolysis was seldom incorrect; while in many persons in whom it was hoped to perform a complete pneumonolysis this could be only partially accomplished, if at all.

This report is based on 143 operations on 115 patients. In 65 cases complete pneumonolysis was carried out

(i.e., all adhesions preventing effective collapse of the lung were freed), and in 59 of this group relaxation of the lung was satisfactory. In 35 patients an incomplete pneumonolysis was done, and in 11 of these relaxation was satisfactory. The operation was thus of value in 70 cases.

In 10 of the 115 patients major complications developed. Severe hemorrhage occurred in 3 cases, and empyema in 7, including 1 of the 3 with hemorrhage. In 5 the empyema was proved to be tuberculous, while in the remaining 2 it was believed to be so. In 4 instances the empyema was secondary to a spontaneous pneumothorax. Spontaneous pneumothorax also developed in 1 additional patient. A subsequent obliterative pleuritis occurred in several cases at varying periods after operation.

The author believes that practically all tuberculous patients undergoing collapse therapy should be given the benefit of thoracoscopic examination and, when possible, pneumonolysis, as the results are better both from the point of view of complications and control of the pulmonary lesion. ELLWOOD W. GODFREY, M.D.

**Syphilis and Pulmonary Tuberculosis in the Negro.** Reuben Hoffman and George G. Adams. *Am. Rev. Tuberc.* 50: 85-95, August 1944.

In an attempt to determine whether the presence of syphilis in the Negro influences the course of pulmonary tuberculosis, comparison was made of a group of adult Negroes who had pulmonary tuberculosis and syphilis with a group who had tuberculosis alone. The material consisted of 1,705 consecutive sanatorium admissions. Of the 1,705 patients, 507 had positive serologic tests. The percentages of syphilis in the minimal, moderately advanced, and far advanced stages of tuberculosis were fairly comparable, being 24.7 per cent, 29.2 per cent, and 31.1 per cent, respectively. No significant differences were noted in the pathologic types of the tuberculous disease in the two groups and the death rates were similar. The conclusion is reached that the presence of syphilis does not alter the course of pulmonary tuberculosis.

Concerning the question of antisyphilitic treatment in patients with tuberculosis, it is recommended that such treatment be given only when the prognosis for the latter disease is good. Two conditions offer exceptions to this rule, i.e., pregnancy and the presence of syphilis in an infectious stage. These require antisyphilitic therapy regardless of the outcome of the tuberculosis.

L. W. PAUL, M.D.

**Postoperative Emphysematous Bullae Following Lung Abscess.** Waldo R. Oechsli. *Am. J. Roentgenol.* 52: 145-148, August 1944.

A case is reported of a patient with a lung abscess which was drained surgically, following which there was a clinical cure. Postoperative roentgen studies, including planigrams, revealed persisting shadows, which were interpreted as emphysematous bullae, in the region of the previous abscess. The walls of these rarefactions were thin, being of uniform thickness, and there was no associated density in the adjacent lung. The case is reported as another residual complication following lung abscess. Such bullae, if seen for the first time without a knowledge of the preceding infection, might be diagnosed as congenital cystic disease.

L. W. PAUL, M.D.

**Benign Pulmonary Changes in Arc-Welders: Arc-Welder's Siderosis.** J. A. Groh. *Ohio State M. J.* 40: 732-735, August 1944.

Pulmonary changes demonstrated roentgenographically in arc-welders' chests have been observed since 1936. They were believed to occur only when welding was done in closely confined and poorly ventilated spaces. The author studied 83 of 125 welders in an industrial plant providing screening from ultraviolet radiation and suction ventilation in a large open building. These precautions were considered adequate protection.

After exclusion of all with histories of exposure to silica dusts, 71 per cent of the welders were found to have fine nodulations evenly distributed over the lung fields. The individual lesions varied from 1 to 3 mm. in diameter, were sharply defined, roughly rounded, and more numerous near the hila. The lungs were normal except for the nodulations. There was no evidence of enlarged hilar nodes, increased fibrous tissue, inflammatory changes, thickened pleurae or septa, or adhesions. These points are important in differentiating from silicosis. Miliary tuberculosis must be ruled out by clinical findings.

The cases were divided, according to extent of involvement, into minimal and extensive groups. Fifty-six per cent of the positive cases showed extensive involvement. On the average, those showing no involvement had been welding 6.7 years; those with minimal involvement 8.5 years; those with extensive involvement 9.2 years. Six non-welders working as welders' helpers showed no involvement, indicating that close approximation to the fumes and inadequate ventilation are important etiologic factors.

This series represents a higher incidence than ever previously reported, in spite of the fact that these men did not work in closely confined, supposedly ill-ventilated places. No cases of active tuberculosis were found; 5 men showed fibrotic or calcified lesions with no reactivation though they had been engaged in welding from five to ten years. The evidence cited here and elsewhere shows that arc-welder's siderosis does not predispose to tuberculosis or reactivate old tuberculous lesions.

The pathological changes were described by Enzer and Sander (*J. Indust. Hyg. & Toxicol.* 20: 333-350, May 1938) as deposits of iron oxide along the pulmonary lymph channels and in the regional nodes without any scarring or fibrosis. These undoubtedly account for the minute nodulations seen radiographically with absence of secondary changes.

Some men who had been welding as long as sixteen years showed no changes. This is explained by variations in ventilation and individual differences, such as a tendency toward mouth breathing and greater or less efficiency of filtration of the upper air passages. None of those showing siderosis had any physical disability, nor was there any evidence to indicate that future disability directly traceable to the siderosis might be expected. This should not encourage carelessness in exposure to welding fumes, however. Rather, when cases of siderosis are discovered, every precaution should be taken to insure adequate ventilation. The author believes that arc-welder's siderosis should not be considered a serious debilitating disease, since such a stigma is easily applied and quickly disseminated but, once accepted, is slowly repudiated.

BERNARD S. KALAYJIAN, M.D.

**Mediastinal Herniation in Artificial Pneumothorax. Case Report of Bilateral Mediastinal Herniation in Bilateral Pneumothorax and Herniation of Extreme Size and Unusual Type.** I. D. Bobrowitz. *Am. Rev. Tuberc.* 50: 150-159, August 1944.

Mediastinal hernia is not infrequently observed during artificial pneumothorax and usually causes no untoward symptoms. It occurs most commonly in the anterior mediastinum, since this is the weakest point. A case is reported in which, following a bilateral pneumothorax, bilateral mediastinal herniation developed. A left-sided pneumothorax was followed by an extensive herniation to the right, which extended across the mid-line to reach the right lateral chest wall and raised the question of a spontaneous pneumothorax on that side. The correct diagnosis was established by the injection of saline into the left pleural cavity and demonstration of a fluid level on the right. When a right pneumothorax was instituted, a similar herniation developed to the left, with the right-sided herniation persisting. Both herniations traversed the anterior mediastinal space. No symptoms were produced by these massive herniations. L. A. PAUL, M.D.

### THE DIGESTIVE SYSTEM

**Benign Tumors of the Stomach.** Edward B. Dewey. *Am. J. Surg.* 65: 233-237, August 1944.

That benign tumors of the stomach are relatively rare is attested by the fact that during the past twenty years only 5 patients with this type of tumor have been admitted to the Huntington Memorial Hospital, Pasadena. Malignant change is frequent and had occurred in 2 of the 4 myomas in this series; in the fifth case the tumor was a benign papilloma.

Anemia, dyspepsia, and vomiting are frequently associated with benign gastric neoplasms. In the diagnosis, roentgenoscopy and gastroscopic examination are most important. The roentgen picture is characteristic, showing smooth, punched-out filling defects, most easily seen in the partially filled stomach. Peristalsis is only slightly interfered with, and surface ulcers are readily demonstrable. Rugae commonly are normal to the base of the tumor. Gastroscopy is of value especially in viewing the smaller tumors. Large tumors, however, may be seen only in part, and in such cases roentgen examination is more trustworthy.

Surgical treatment of benign tumors of the stomach is generally satisfactory, and the mortality is low.

**Giardiasis with Unusual Findings.** P. B. Welch. *Gastroenterology* 3: 98-102, August 1944

Twenty-nine cases of giardiasis are presented, including 13 previously reported from a clinical point of view (Welch: *Am. J. Digest. Dis.* 10: 52, 1943). All of the original 13 cases showed roentgen evidence of functional and/or anatomic changes in the duodenum, duodenal cap, pylorus, and prepyloric area of the stomach. Two of the patients had duodenal ulcers, which, of course, were not ascribed to the giardiasis. There were also 2 cases of pyloric hypertrophy, one of which was definitely aggravated by the associated giardial infestation. This leaves 10 cases, or 77 per cent, with roentgen changes in the peptic area attributable to giardiasis.

Of the 16 more recent cases, 8 were in adults and 8 in children from three to seventeen years of age. The 8 adults all presented abdominal symptoms. In the

children, *Giardia* were found on routine stool examinations; abdominal symptoms were present in only 3. Roentgen changes were found in the 7 adults examined. Duodenal ulcer was present in one of these, and gastric ulcer in another. Since in these cases the associated changes could not be ascribed to giardiasis alone, the incidence of positive findings is given as 5 out of 7, or 71 per cent, for the adult group. X-ray examination showed changes in the peptic area in 6 of the 8 children (75 per cent). In 4 of these no abdominal symptoms were present. Thus 11 of the 15 patients examined roentgenographically, or 73 per cent, showed evidence of anatomic or functional changes in the peptic area attributable to the parasite.

Of the combined series of 28 cases examined roentgenographically, findings attributable to giardiasis were present in 21 (75 per cent). Signs of duodenal irritation were found in 50 per cent of 24 cases reported by Spears (*Rev. Gastroenterol.* 6: 512, 1939).

The eosinophil count varied from 4 to 13 per cent in 22 of the author's 29 cases (approximately 76 per cent). This count was found to have returned to normal in 16 of the 21 patients re-examined after treatment with atabrine. A relatively high white blood count, 10,000 or over, was encountered in 15 cases, with a drop after atabrine therapy in 11.

**Management and Prognosis of Megacolon (Hirschsprung's Disease): Review of Twenty-four Cases.** K. S. Grimson, H. N. Vandegrift, and H. M. Dratz. *Am. J. Dis. Child.* 68: 102-115, August 1944.

A study of the 24 cases of Hirschsprung's disease seen in the Duke Clinic, since its opening in 1930, suggests a definite plan of treatment determined by the anatomic distribution of the megacolon. The cases are divided into 3 groups: Group I, 12 patients, with uniform involvement of the entire colon terminating in a dilated or easily dilatable rectum; Group II, 7 patients, with uniform dilatation of the proximal colon terminating in a normal bowel segment, usually in the sigmoid, and a normal rectum; Group III, 5 patients, with enormous enlargement of the sigmoid or the sigmoid and descending colon with or without some enlargement of the proximal segments of the colon and the rectum. The case histories are given and numerous roentgenograms are reproduced.

Medical management consisting chiefly of diet, laxatives, enemas, and parasympathomimetics is advised in treatment of Group I patients as long as adequate nutrition can be maintained and persistent distention avoided. Sympathectomy is of questionable value, as it does not alter the gross pathologic condition and, by interrupting the visceral sensory pathways, may permit negligence on the part of the patient, with resultant impaction. Since, according to the literature, segmental resection is often followed by recurrent impactions proximal to the anastomosis, resection, when necessary, should start at the ileocecal junction, with removal of the entire megacolon. Of the authors' 12 patients in this group, 8 were living and evacuating the colon readily at an average age of ten years. One patient, aged 24, died three years following a sympathectomy. One patient, aged 6, was having moderately severe trouble at the time of the report; one required surgical reduction of a volvulus at the age of 20; and one had a reduction of a sigmoid volvulus at the age of 59 with a recurrence in three months, at which time sigmoidectomy was performed.



Group II has the gravest prognosis because of the ease with which intestinal obstruction may develop. Of the 7 patients in this group, 4 receiving conventional treatment died, 2 at the age of 15 months, 1 at 9 years, and 1 at 17 years. The remaining 3 had equally severe symptoms and as enormous colons as the others. They are living and well following complete resections of the megacolon at the ages of 2, 11, and 21 years, with anastomoses between the ileum and the normal sigmoid stump. Preliminary colostomy may be necessary in severe acute obstruction.

The 5 patients of Group III, having dilatation of the sigmoid, are all living at an average age of 16 years, 2 free from symptoms and 3 with moderately severe symptoms. Protracted medical management is considered justified in this group, and it is believed that in patients with normal segments of sigmoid colon and normal rectums these structures may become progressively dilated and accomplish massive evacuation of impactions.

Repeated barium roentgen studies are advocated to determine the progress of the condition and as an aid in determining the choice between protracted medical treatment and resection. Roentgenography is of particular importance following decompression of the bowel, since a normal rectum or sigmoid may appear enlarged during delivery of an impaction.

LESTER M. J. FREEDMAN, M.D.

**Treatment of Large Bowel Obstruction. Transverse Colostomy—Incidence of Incompetency of Ileocecal Valve: Experience at the University of Minnesota Hospitals.** Clarence Dennis. *Surgery* 15: 713-734, May 1944.

The most common cause of acute obstruction of the colon is a carcinomatous stricture. According to figures from the Mayo Clinic, two-thirds of the colic cancers causing obstruction involve the descending, sigmoid, or rectosigmoid colon, while only one in seven lies cephalad to the splenic flexure. Extracolonic neoplasms and pelvic and sigmoid inflammatory lesions rank second in etiologic importance, with volvulus of the sigmoid a poor third, at least in America. Partial obstruction is much more common than complete, but it is not easy to evaluate statistically and is not considered here.

The low position of the obstructing lesion in the intestinal tract usually permits absorption by the bowel higher up of much of the food, water, and salt taken by mouth, and patients are therefore relatively free from hypochloremia, uremia, and severe dehydration. A factor further tending to inhibit chemical imbalance is the frequent absence of severe vomiting, commonly attributed to competency of the ileocecal valve. A competent ileocecal valve is also of significance since it renders colic occlusion a type of "closed-loop" obstruction.

Early in left colic obstruction, distention may occur just proximal to the lesion, and, since peristaltic rushes are far less frequent here than in the ileum, cramps and borborygmi may be present at intervals of from ten to thirty minutes or longer. Later, as the entire proximal colon becomes distended, this interval is reduced to three to ten minutes, corresponding to the interval between major contraction waves in the ileum. It may be shorter if distention extends higher in the small bowel or, later in the process, cramps may be absent altogether.

Scout films of the abdomen regularly show distention of the colon from the cecum to the point of obstruction. Gas due to stasis is frequently demonstrable in the terminal ileum, and distention of the small bowel may occasionally be present. Barium enema studies not only may fail to reveal the site of obstruction, but may convert a partial obstruction into a complete one.

Small bowel obstruction is differentiated by the almost constant presence of vomiting, often of fecal character, by the consistent occurrence of cramps at intervals of less than ten minutes, and the ladder-like arrangement of loops of small bowel usually apparent on the scout film. Infrequently, colic obstruction, especially if situated in the right colon, may simulate small bowel obstruction in all these respects.

Preoperative diagnosis of volvulus of the sigmoid colon is of great practical importance, for it is fundamentally a greater threat to the blood supply of the sigmoid loop than simple obstruction is to that of the cecum. In volvulus there is usually a history of constipation, and the condition is particularly apt to occur in patients with megacolon. There is likely to be a history of previous attacks and recent sudden onset of abdominal pain with increasing distention and failure to pass flatus. Roentgen pictures usually show a single loop far more enlarged than others, with a tendency to extend up to the right upper quadrant and even, at times, to overlie the liver.

In simple obstructions, experience has shown that preliminary decompression reduces the risk of resection by more than half. For this purpose, transverse colostomy with a transverse incision, preferably across the right rectus muscle between the umbilicus and the xiphoid, as described by Wangenstein, is recommended. When the lesion lies in the right colon, insertion of a catheter into the cecum by way of the appendix or the terminal ileum must be performed, cecostomy being reserved for only the rarest occasions. Volvulus of the sigmoid colon is potentially a strangulating obstruction and, as such, demands immediate detorsion as well as decompression of the colon proximally.

The author reports a series of 54 cases of colic obstruction seen over a period of six years. Of these, 35 were due to carcinoma of the colon or rectum. The incidence of complete obstruction in cancer of the colon during this same time was 9.5 per cent. Twenty-eight of the 35 patients with carcinoma had obstruction of the left colon, and 6 in the region of the hepatic flexure. One had a lesion in the transverse colon, involving the ileum as well. Among other causes of obstruction in the series were neoplasms elsewhere in the pelvis involving the colon secondarily, pelvic inflammatory lesions, volvulus of the sigmoid, and impaction of feces following a barium meal. In 9 cases an incomplete obstruction became complete following the introduction of a barium mixture either by mouth or as an enema.

Transverse colostomy was done in 38 cases of acute left colic obstruction, of which 25 were due to intrinsic cancer. Among the 38 cases there were but 3 deaths, a mortality rate of 7.9 per cent. None of the deaths, however, was directly attributable to the performance of the colostomy. Inguinal colostomy was done in three low-lying obstructions, with no deaths.

There were 6 cases of right colic obstruction due to carcinoma. Three of the patients were treated by terminal double-barreled ileostomy with insertion of a catheter through the ileum and into the cecum; an appendicostomy was done in one, and decompression



by Miller-Abbott tube in 2, each of these last being subjected three days thereafter to hemicolectomy with primary end-to-end ileotransversostomy. There were 2 deaths in this series.

The author includes some "observations on the incidence of vomiting and of small bowel distention in acute colic obstruction." He quotes Wangenstein as pointing out that fecal emesis usually indicates small bowel obstruction, while in the majority of instances of colic obstruction the ileocecal valve prevents reflux into the ileum and vomiting of fecal character. Competency of the ileocecal valve has been adopted by many radiologists as an aid in the diagnosis of colic obstruction, absence of gas visible in the ileum confirming this impression. In a little more than two-thirds of the author's group, the films presented some definite evidence of gas in the ileum, about one in three presented real ileac distention, and in fewer than 8 per cent was the small bowel distention more striking than the distention of the colon. About one-third of the patients who vomited showed no intra-ileac gas on the films. This vomiting, therefore, must be explicable as reflex in nature.

It is apparent from the author's observations that competency of the ileocecal valve is usually but by no means invariably present in obstructive lesions of the colon. There was definite regurgitation into the small bowel in about one-third of his series, and vomiting occurred in about 12 per cent. The presence of vomiting, therefore, even if persistent and fecal in character, should not cause the examiner to overlook entirely the possibility of large bowel obstruction.

J. E. WHITELEATHER, M.D.

**Difficulties in the Roentgenological Examination of the Biliary Tract.** Adrian J. Bengolea, Carlos Velasco Suarez, and Alfredo Negri. *Am. J. Roentgenol.* 52: 149-164, August 1944.

Cholangiography is a useful procedure in the post-operative study of the bile ducts not only for the demonstration of calculi but in certain other physiologic and pathologic disturbances of the biliary tract. In this latter connection the method is not infallible and errors of interpretation may be made. The present report discusses some of these and methods to avoid them.

Calculi may be obscured if they are small and covered with the opaque medium or if complete filling has not been obtained. When the common or one of the hepatic ducts is obstructed, the margin of the opaque shadow will be sharply outlined and concave. The calculus itself may not be visible, but its presence may be suspected by other alterations, such as dilatation of the biliary tree, failure of passage of the medium into the duodenum, or failure to outline one or both hepatic ducts. Injection of air bubbles may cause false images. Careful technique, repeated roentgenograms, and the use of sufficient contrast medium help to avoid these mistakes.

The second part of the report is given over to a consideration of the use and value of cholangiography in studying biliary tract physiopathology. It is believed that too much information should not be expected from this type of roentgen study. Filling of the pancreatic duct has been reported as evidence of contraction of the sphincter of Oddi. The authors believe that there are other reasons, including the normal mucosal folds in the ampulla of Vater, which may act as valves, and, even more important, hyperplasia of the mucosa in the

ampulla. In all of these so-called functional disturbances, where the surgeon is unable at operation to find any obvious cause for obstruction and jaundice, care should be exercised in the interpretation of subsequent cholangiograms, since many of these functional disturbances are poorly understood and roentgen examination alone may not be sufficient to establish a diagnosis.

L. W. PAUL, M.D.

**Calcification of the Pancreas.** Case Report. Charles M. Graney and Robert H. Reddick. *Am. J. Surg.* 65: 271-275, August 1944.

There are two distinct types of pancreatic calculi: (1) true stones found in the pancreatic ducts, corresponding to stones in the gall ducts or ureters; (2) false stones or calcification of the gland, in which the stones occur chiefly in the parenchyma and less often in the ducts. A case of the latter type is presented.

## THE PERITONEUM

**Roentgen Features of Chronic Tuberculous Peritonitis.** James J. McCort. *Arch. Surg.* 49: 91-99, August 1944.

Peritoneal infection with the tubercle bacillus may be acute or chronic. The acute type may take the form of a miliary tuberculous peritonitis as a part of generalized miliary tuberculosis, or a localized peritonitis with involvement of a few lymph nodes and the adjacent peritoneum. This second type, through breakdown of the tubercles in a person with lowered resistance, may lead to a chronic generalized tuberculous peritonitis. The result is a diffuse adhesive process involving the peritoneal surfaces. This adhesive tendency leads to features which, while not pathognomonic, are strongly suggestive of the condition. These diagnostic points are: (1) a low-grade ileus with variable amounts of intra-abdominal fluid, demonstrable on the plain roentgenogram; (2) fixation of the entire large bowel, demonstrable with the aid of a barium enema, especially by absence of change of position on evacuation (actual adhesions can occasionally be shown); (3) abnormally rapid passage of barium through the small intestine, following a small-intestinal enema, with binding together of loops and shortening of the bowel. The intervals between barium-filled loops tend to be widened and irregular, with abnormal segmentation.

Six illustrative cases are recorded, in 3 of which the employment of the criteria noted led to a correct pre-operative diagnosis.

LEWIS G. JACOBS, M.D.

## THE SKELETAL SYSTEM

**Osteogenesis Imperfecta and Osteopsathyrosis. A Contribution to the Study of Their Identity and Their Pathogenesis.** S. Rosenbaum. *J. Pediat.* 25: 161-167, August 1944.

The question of whether the "early type" of fragilitas ossium with intrauterine fractures (osteogenesis imperfecta, type Vrolik) is essentially different from the "late type" with only postnatal fractures (osteopsathyrosis, type Lobstein) is as yet unsolved. The pathogenesis is likewise indeterminate. Glanzmann (*Schweiz. med. Wchnschr.* 66: 1122, 1936. *Abst. in Radiology* 28: 639, 1937) favors the duality of the two syndromes. In his opinion the "early type" is not hereditary; the limbs are shortened (micromelia), the cranium consists only of small islands of bony structure,

the calcium level in the serum is elevated, the concentration of serum inorganic phosphorus is at the upper limits of normal, and the total duration of life rarely, if ever, exceeds four years. He regards the "late type" as a qualitatively different disease in that the body proportions are normal; the bony deformities are found in the middle of the shafts, the cranium is unyielding, the calcium level in the serum is normal, serum inorganic phosphorus is low, and life expectancy is not curtailed. Funk (Schweiz. med. Wchnschr. 70: 473, 1940. Abst. in Radiology 37: 123, 1941) states that cases of osteopsathyrosis (Lobstein) never occur with cases of osteogenesis imperfecta (Vrolik) in the same family.

A number of cases are presented here to show the relationship between the two disease syndromes. Two infants who in highest likelihood suffered from intrauterine fractures and exhibited the other characteristics of osteogenesis imperfecta (Vrolik) came from a typical Lobstein family, in which three previous cases of fragilitas ossium are known to have occurred—in the mother, an aunt, and the great grandmother. All of the fractures sustained by these women were of postnatal origin. Both children survived their fifth year.

Another case represents a typical example of the Lobstein syndrome. The value of the serum calcium, however, was subnormal when first measured (when the patient was 7 1/2 years of age) and not until she was 11 1/2 did it reach normal. The serum inorganic phosphorus was at first elevated, later normal, or slightly below normal. This patient's brother sustained a fracture of the femur when fourteen days old and a fracture of the forearm when nine years old. His sclerae were blue and the tympanic membranes blue-gray.

The fifth case is that of a male child who at the age of twenty-two months suffered from a typhoidal meningoencephalitis and subsequently exhibited the clinical picture of osteopsathyrosis with decalcification of the skeleton, fractures of the femora, and deformities of the ribs and vertebral bodies. On roentgen examination of the cranium, signs of increased intracranial pressure were found. Osteosclerotic proliferation of the margins of the vertebral bodies was observed.

On the basis of his observations, the author concludes that osteogenesis imperfecta of the Vrolik type and osteopsathyrosis of the Lobstein type are different manifestations of a single disease. The pathogenetic relationship between cerebral disease and osteoporosis is discussed. As in the fifth case, osteopsathyrosis may develop after cerebral disorders and presumably in response to them. The suggestion is made that an alteration in the region of the hypophysis or infundibulum may provisionally be regarded as the origin of skeletal abnormality both in typical cases of osteopsathyrosis (Lobstein) and in osteogenesis imperfecta (Vrolik). Consonant with this hypothesis is the well known circumstance that fresh spontaneous fractures do not occur in osteopsathyrosis after puberty. Acting on this theory, the author treated cases of osteopsathyrosis with extracts of anterior pituitary and found the results encouraging. He recommends its use in the treatment of this condition.

**Roentgenographic Studies of the Cervical Spine.** Lee A. Hadley. *Am. J. Roentgenol.* 52: 173-195, August 1944.

Studies of the cervical spine in the lateral projection in extremes of flexion and extension and in 45° oblique views give valuable information as to the mobility of

the vertebral segments, the condition of the disks, and the intervertebral foramina in a variety of pathological conditions. The author describes and illustrates the normal appearances in these various projections and discusses some of the lesions encountered in this region.

Traumatic lesions to be searched for include partial bilateral subluxations and unilateral subluxation. Spontaneous subluxation of the atlas is found, as a rule, in children complaining of stiff painful neck, usually of sudden onset. Lateral roentgenograms reveal a space between the anterior arch of the atlas and the odontoid and show the posterior arch of the atlas well forward on those below. Other conditions discussed include disk degeneration, spondylitis deformans, and foramen encroachment. Encroachment on the foramina may occur in at least six ways. It may be (1) physiological, due to dorsal extension, or may be the result (2) of trauma, as in fracture or, rarely, a posterior subluxation, (3) of arthritic processes with bony exostoses projecting into the foramina, (4) of thinning of the intervertebral disk, allowing the bodies to come closer together, (5) of fibrous hyperplasia of the posterior joint capsule, or (6) of a tumor.

Congenital anomalies of the cervical spine include various types of fusion such as the Klippel-Feil syndrome and platybasia. The latter may be congenital, with varying degrees of fusion between the atlas and the occiput, or acquired as the result of softening of the base of the skull, as seen in Paget's disease, etc.

In connection with platybasia it is pointed out that the arch about the foramen magnum may assume certain features resembling a vertebral segment, the occipital vertebra. The foramen magnum may be distorted as a result of this anomaly and surgical treatment may be in order. In these cases the atlas is normal but the bony structures around the foramen magnum suggest a partially formed, fused vertebral segment.

L. W. PAUL, M.D.

**Effect of Increased Intraspinial Pressure on the Movement of Iodized Oil within the Spinal Canal.** Bernard S. Epstein. *Am. J. Roentgenol.* 52: 196-199, August 1944.

During roentgenoscopy in the course of iodized oil myelography the authors noticed that the oil column rose in the lumbar canal when the patient coughed or strained, as at stool. The ascent of the oil column usually was rapid, reaching its maximum in a few seconds. This is believed to be due to an increase in the amount of blood in the venous plexus between the dura and the walls of the spinal column. This procedure is advocated as a routine during myelography, as small indentations on the oil column may be brought into bolder relief and the axillary pouches above the area under immediate scrutiny often can be filled.

L. W. PAUL, M.D.

**Pain and Disability of Shoulder and Arm Due to Herniation of the Nucleus Pulposus of Cervical Intervertebral Disks.** Jost J. Michelsen and Wm. J. Mixter. *New England J. Med.* 231: 279-287, Aug. 24, 1944.

The prominent place held by lumbar disk lesions somewhat beclouds the fact that the condition can occur at other spinal levels. This article reviews the literature of cervical disk lesions and presents 8 cases.

The patient with a cervical disk lesion usually complains of pain and paresthesias over the shoulder and down the arm. In most cases there is a history of injury, although the pain and paresthesia may not appear until some time later. The pain is usually described as stabbing, shooting, sharp, or acute. Rarely is there pain over the spine, although a spinous process may be sensitive to pressure. Sneezing and coughing may accentuate the pain. Muscle weakness may be present. Spinal fluid protein is elevated or at a high normal.

Roentgen examination of the spine may show a narrowed interspace, absence of cervical lordosis, or hypertrophic change. The lesion may be demonstrated by lipiodol examination of the spinal canal.

The dermatomes of the upper extremity do not seem to be worked out sufficiently accurately to make an exact identification of the level of injury, but they are of some help. More extensive experience with this lesion will doubtless be a means of more accurate definition of the dermatomes.

Operative procedures adequately relieve the disability.

JOHN B. McANENY, M.D.

**Pneumoradiography of the Knee Joint.** Francis Blonek and Joseph Wolf. *J. Iowa M. Soc.* 34: 354-360, August 1944.

Three methods have been employed for demonstrating intra-articular structures of the knee joint with the aid of contrast media: (1) like the negative contrast with substances giving a less dense shadow than body tissue, such as air, oxygen, nitrogen, carbon dioxide, and helium; (2) positive contrast, with radiopaque substances giving a more dense shadow than body tissue, as solutions of metal salts, various compounds of iodized oil, or watery solutions of iodides; (3) a combination of the two, or the double contrast method. The authors' method of pneumoradiography falls in the last classification. After injection of an opaque fluid and oxygen inflation, three antero-posterior films are taken with the patient supine and in right and left lateral positions and the x-ray beam in the horizontal position. Since each time the gas collects at the highest level, different parts of the joint are thus outlined. Additional lateral and, if necessary, oblique views will show further details.

In a pneumoroentgenogram of the knee joint, the following structures besides the bones will be visible: (1) the hyaline cartilages of the femur, tibia, and posterior aspect of the patella, appearing as a slightly grayish layer, coating the articular planes of the bones and outlined against the joint cavity by a fine dense line formed by the thin film of the opaque fluid; (2) both menisci and their attachment to the fibrous capsule and, on lateral views, to the transverse ligament; (3) the attachment of both cruciate ligaments to the intercondyloid eminences of the tibia (oblique views may show some of their length); (4) the synovial membrane and joint cavity, the former represented by a thin line of varying density produced by the coating opaque fluid (in the pouches often larger amounts of contrast material are deposited, which has the undesirable effect of obscuring details); (5) the infrapatellar fat pad, which in plain films is seen as an area of decreased density and in pneumoroentgenograms appears inversely as increased density contrasting with the gas-filled transparent anterior compartment; (6) the plicae alares, if pathologically condensed and thus demarcated against the gas-filled joint space; (7) the pouches of the joint

cavity, filled with gas and distinctly demonstrated as transparent dark areas.

**Dislocation of the Knee Joint. A Report of Two Cases.** James Warren Sever. *New England J. Med.* 231: 318-319, Aug. 31, 1944.

Two case reports of dislocation of the knee are presented because of the rarity of this condition. Anterior dislocation is the most common type, accounting for 40 per cent of all knee dislocations; posterior dislocation accounts for 20 per cent; lateral dislocation for 20 per cent; and medial for about 7 per cent (13 per cent are unaccounted for).

In one of the reported cases the dislocation was anterior; reduction was accomplished without great difficulty and a good result was obtained. The second patient had a posterior dislocation complicated by fracture of the upper tibia and compounding. A good result followed.

Injury to the nerves and vascular structures may be expected with these injuries, and make treatment more difficult.

JOHN B. McANENY, M.D.

**Aseptic Necrosis of the Head of the Femur Following Traumatic Dislocation of the Hip.** S. Kleinberg. *Arch. Surg.* 49: 104-108, August 1944.

This report calls attention to the fact that traumatic dislocation of the hip may occur without rupture of the ligamentum teres and records an instance of typical aseptic necrosis of the femoral head in spite of an intact and normally vascularized ligamentum teres.

The patient was a man of 20 who had suffered a simple dislocation of the right hip, immediately reduced, four years before. He was allowed to walk after two weeks. A year later a painful limp developed, which was gradually progressive. Examination showed all motions of the hip to be limited and the muscles atrophied. Roentgenograms showed enlargement and irregularity of the femoral head with spotty areas of vacuolization and sclerosis; the upper surface was flattened and the articular surface irregular. This was considered an aseptic necrosis with secondary osteoarthritis. An arthroplasty was done, permitting study and biopsy of the joint structures. The ligamentum teres and capsule were grossly normal and microscopically showed normal vascularization. The femoral head showed microscopic changes typical of aseptic necrosis. The author's explanation is that the force producing the dislocation tore the capsule and its blood vessels, depriving the femoral head of a large source of its blood supply. As a result there ensued an aseptic necrosis with collapse of the bony structure, arising from too early weight bearing.

LEWIS G. JACOBS, M.D.

**Spontaneous Fracture of the Calcaneus.** Victor Raisman. *Am. J. Surg.* 65: 290-292, August 1944.

A case of spontaneous fracture of the calcaneus in a middle-aged woman with syphilis is reported. Lateral roentgenograms of the foot and ankle five days after the onset of symptoms showed a fracture of the apophysis with an upward displacement of the proximal two-thirds. Under conservative treatment, the pain, swelling, and tenderness disappeared and x-ray studies three months after the occurrence of the fracture showed firm union of the displaced apophyseal fragment.

## GYNECOLOGY AND OBSTETRICS

**Determination of the Placental Site in Bleeding During the Last Trimester of Pregnancy.** James J. McCort, Charles N. Davidson, and Henry J. Walton. *Am. J. Roentgenol.* 52: 128-135, August 1944.

The literature on the subject of the roentgen diagnosis of placenta praevia and placental visualization is reviewed. The present report is based on the results of roentgenographic examination in 132 cases. Routinely, an antero-posterior and a lateral roentgenogram of the abdomen were taken, with soft-tissue technique, as recommended by Snow and Powell (*Am. J. Roentgenol.* 31: 37, 1934). If the placenta could not be clearly demonstrated in the upper uterine segment, it was considered to be a placenta praevia. In doubtful cases pneumocystograms were obtained after injecting 200 to 250 c.c. of air into the bladder, antero-posterior and lateral views again being taken.

In those cases negative for low implantation or placenta praevia, the vesiocephalic measurement averaged 1.2 cm. In the positive cases the average measurement was 2.0 cm. A sign of additional importance was displacement of the bladder to one side. This occurred when the placenta was implanted on the lateral uterine wall and extended into the lower uterine segment. When the placenta lies posteriorly, the pneumocystograms may be normal. In these cases a widening of the distance between the sacral promontory and the fetal head should be present. Similarly in anterior implantations a widening of the symphysis pubis-fetal head distance should be present. For the entire group of 132 patients, a correct diagnosis was made in 87.8 per cent; of the negative diagnoses, 97 per cent were correct. L. W. PAUL, M.D.

**Relationship of Descensus Uteri to Pelvic Size and Morphology and to Certain Obstetric and Economic Factors.** A. L. Dippel. *Minnesota Med.* 27: 627-631, August 1944.

In an attempt to assign some role to pelvic size and morphology in uterine prolapse, a series of 25 cases was investigated by stereoscopic roentgen pelvimetry and by clinical measurement of the pelvis before operation. The average age of the patients at the time of the prolapse was 42.8 years, with extremes of 21 and 63 years. The majority of the women fell within normal limits as to stature and weight. None of the pelvis studied was classified as contracted. Fourteen were gynecoid, 10 platypelloid, and 1 android.

Roentgen findings other than pelvic form included moderate rachitic changes in the sacrum in 9 cases. Four pelvis showed high assimilation. One was slightly asymmetrical. There were no instances of spina bifida. In 6 cases, however, the hiatus sacralis involved the lower two or three sacral vertebrae. The significance of this minor developmental anomaly in the lower end of the vertebral column is not clear, but it would seem possible that it might be associated with other anomalies in the development of the neural canal which might conceivably, like spina bifida, be responsible for the production of pelvic relaxation on a neurogenic basis.

As to the obstetric history and economic status of the patients, the author comes to certain conclusions:

"The following factors do not seem to play an important role in the production of descensus uteri: age at onset of symptoms, age at time of first term delivery, age at menopause, parity before onset of symptoms, num-

ber of operative vaginal deliveries, and presence of open saeral canal.

"Parity with associated birth trauma is almost always an accompaniment of descensus or prolapse.

"Descensus uteri is much more common in low income groups." Early resumption of hard physical labor following delivery may here be the dominant factor.

PERCY J. DELANO, M.D.

## THE GENITO-URINARY TRACT

**Supernumerary Ureter with Extravesical Orifice.** Wm. W. Scott. *J. Urol.* 52: 126-132, August 1944.

In ureteral duplication the insertion of the ureter draining the superior pole of the kidney is always caudad and medial to that of the ureter draining the lower portion of the kidney. Thus, if there are duplicate ureters one of which has an extravesical orifice, that ureter will always drain the superior pole of the kidney.

Although ureteral duplication is of equal incidence in the sexes, the patients seen are chiefly females. In the male, the extravesical orifice is in the prostatic urethra, seminal vesicle, vas deferens, or ejaculatory duct, where it will not produce incontinence. In the female, on the other hand, incontinence is the cardinal symptom. The author states that a break-through between the wolffian and müllerian ducts will explain the anomaly.

The extravesical orifice may be extremely hard to find. In cases of long-standing infection of the supernumerary ureter, the function of that portion of the kidney drained by this ureter may be so low that there will not be enough clearance of the drugs used in intravenous urography for radiographic detection, or enough clearance of dyes to detect their color in searching for the orifice. With a history of incontinence with normal micturition, the finding of a superior segment of kidney with no apparent drainage system is strongly suggestive of the diagnosis.

The author recommends heminephrectomy as the treatment of choice. In one of his 4 reported cases the orifice was never found; in 2 it was in the urethra, and in the other in the vicinity of Skene's gland. Heminephrectomy produced cure in all cases.

J. FRANCIS MAHONEY, M.D.

## THE BLOOD VESSELS

**Use of Radioactive Sodium in Studies of Circulation in Patients with Peripheral Vascular Disease: A Preliminary Report.** Beverly C. Smith and Edith H. Quimby. *Surg., Gynec. & Obst.* 79: 142-147, August 1944.

Having recognized the need of a practical procedure for determining the arterial flow through the main and collateral circulations of the extremities, the authors devised a method whereby radioactive sodium is injected intravenously at the antecubital fossa and its arrival in other parts of the body is recorded with a Geiger-Müller counter. Thus the circulation time can be determined and the rate at which the radioactive isotope comes to equilibrium with extravascular sodium can be studied by repeated counting following the injection. Studies were made on a group of 60 persons, of whom 10 were normal and 50 diseased. The information obtained was a valuable adjunct in determining the patency of the main and collateral circulations. Preoperative studies were confirmed by amputation in some of the cases. No local or systemic reactions were noted.

The method of preparation of the radioactive sodium is summarized. In 5 c.c. of normal saline containing 200 microcuries of radiosodium, fewer than 1 in 10 million sodium atoms are active. However, the ordinary and radioactive ones are indistinguishable until the latter disintegrate. An extremely small amount of magnesium is formed as a result of the disintegration.

A detailed description of the technic is given. The circulation times determined were of clinical value, but the curve of equilibrium build-up is more promising. There is a constant interchange of sodium between the blood plasma and extravascular fluid. Consequently, the amount of radioactive isotope gradually increases in any particular region until equilibrium is reached. In scleroderma, Raynaud's disease, and arteriosclerosis not complicated by diabetes, the equilibrium count curves remained consistently low. Some thromboangiitis obliterans patients with good collateral circulation had normal curves. In 2 cases of "immersion foot" and one of frostbite low curves were also obtained.

Since the amount of radiation received by the patient's body is less than 1 r, it is believed this method will be of aid in the follow-up and evaluation of therapeutic procedures. C. R. PERRYMAN, M.D.

### MISCELLANEOUS

**Abdominal Tumors of Questionable Origin: Roentgenological Aspects.** Adolph Hartung. Illinois M. J. 86: 14-16, July 1944.

Roentgen examinations aid greatly not only in arriving at a correct diagnosis, but also in determining prognosis or therapy in practically all masses in the

abdomen of questionable origin. Close co-operation of the clinician and roentgenologist, based on preliminary fluoroscopy or scout films and a knowledge of the existing symptoms, signs, and laboratory findings, will aid in selecting the specific examination, such as contrast studies of the gastro-intestinal tract, pycnography, cholecystography, hepatolienography, pneumoperitoneography and perirenal air injection, necessary for differential diagnosis. ELLWOOD W. GODFREY, M.D.

**Processing X-Ray Films Under Tropical Conditions.** A. Porter S. Sweet. U. S. Nav. M. Bull. 43: 160-161, July 1944.

Excessively high temperatures in film processing solutions will not only destroy most detail of radiographs by fogging, but may so soften the emulsion that it will wash off the base. Sodium sulfate added to the developer makes it possible to use it safely at temperatures up to 110° F. The amount to add will vary with the temperature: 200 gm. per gallon at 80° F.; 300 gm. at 90° F.; 600 gm. at 100° F.; and 800 gm. at 110° F. As the temperature rises, the developing time is reduced: 3 to 4 minutes at 80°; 3 minutes at 90°; 2 minutes at 100°; and one minute at 110° F.

In mixing fixer for use at temperatures above 78° F., only one-half the usual amount of water should be used. The films should be transferred directly from the developer to the fixer with no rinsing in water. This will carry over an extraordinary amount of developer on the film and in the emulsion. Agitation in the fixer helps diffuse the excess developer. It will be necessary to replace the fixer more frequently than normally.

BERNARD S. KALAYJIAN, M.D.

### RADIOTHERAPY

**Roentgen Therapy with the Army X-Ray Field Unit.** Ernest Wayne Egbert. Mil. Surgeon 95: 30-33, July 1944.

The results in 391 cases treated with the Army x-ray field unit are reported. These cases are classified as surgical (chiefly infections) and dermatological. In no case was any deleterious effect observed. Two hundred and forty cases or 61.38 per cent were followed through and the end-results recorded on completion of roentgen therapy or within six weeks thereafter. Of these 240 cases, 90.4 per cent were clinically cured or improved. Only 23 cases were observed with "no benefit" following use of roentgen irradiation. One hundred and eighteen of the 192 dermatological cases (89 per cent) were benefited; 91.8 per cent of the surgical cases were cured or improved.

Roentgen therapy with the army mobile unit is performed in a properly lead-walled room, and a mobile leaded screen gives added protection to the operator. All therapeutic procedures are performed at 100 kv.p. and 4 ma. A special stop-watch, attached on the operator's side of the protective screen, is used to time all treatments. Lead diaphragm inserts in the "useful beam" of radiation limit the field of treatment, and supplementary protection is used in draping the treatment field with lead rubber sections. Dosage calibration for the unit has been checked by the Victoreen apparatus and "r" values have been found within  $\pm 10$  per cent of those given by the manual accompanying the unit.

### NEOPLASMS

**Operability Versus Curability of Cancer of the Breast.** U. V. Portmann. Ohio State M. J. 40: 742-745, August 1944.

The variations in interpretation of the terms "operable" and "inoperable" by equally competent surgeons reporting results of radical mastectomies for carcinoma are cited by the author as probably explaining much of the difference in end-results shown. If the objective is the removal of as much malignant tissue as possible, regardless of the stage of advancement of the disease, the five-year survivals will represent a small part of the total, and many patients will be made worse rather than be improved. If, on the contrary, the objective is to operate only on those patients whose extent of disease warrants the belief that it can be totally removed, the five-year survivals will represent a much larger part of the total. The author believes that if the terms "surgically curable" and "surgically incurable" were used instead of the words "operable" and "inoperable," objectives for treatment would be more clearly defined and more agreement would be reached about the manifestations of incurable cancer.

Much of the uncertainty about the value of irradiation for breast carcinoma is due to lack of proper classification of cases in reporting results. Often advanced cases of the disease treated by irradiation are compared with others far less advanced treated by operation. If survival rates alone serve as standards, such compari-

sons are misleading. In the author's statistical comparison of results in cases treated by operation alone and those by operation plus irradiation, it was found that the classification of cases by clinical and pathological criteria had not been satisfactorily carried out. The anatomical extent of involvement should govern the indications for and the limitations of treatment and the prognosis. A classification based on clinical and pathological criteria was developed referring only to primary cases of carcinoma. It is as follows:

Group I. *Skin*: not involved. *Tumor*: localized in breast and movable. *Metastases*: none in axillary nodes or elsewhere.

Group II. *Skin*: not involved. *Tumor*: localized in breast and movable. *Metastases*: few axillary lymph nodes involved, none elsewhere.

Group III. *Skin*: edematous; brawny red induration or inflammation not obviously due to infection; extensive ulceration; multiple secondary nodules. *Tumor*: diffusely infiltrating the breast; fixation of tumor or breast to chest wall; edema of breast; secondary tumors. *Metastases*: many axillary lymph nodes involved or fixed; no clinical or roentgenological evidences of remote metastases.

Group IV. *Skin*: as in any other group or stage. *Tumor*: as in any other group or stage. *Metastases*: axillary and supraclavicular lymph nodes extensively involved; clinical or roentgenological evidence of more remote metastases.

The author illustrates the applicability of this classification in the study of 1,022 cases of breast cancer, of which 738 were classifiable. The table showing classification by this method is very interesting and should be studied in the original article. Almost half (47.2 per cent) of all primary cases were found to be in Groups III and IV when first examined.

The highest survival rates for surgery alone are obtained in Groups I and II. If postoperative irradiation is of benefit in prolonging life, it should be evident in the results obtained in Groups III and IV. In these groups, there were 5.8 per cent five-year survivals with operation alone, while among those receiving postoperative irradiation the five-year rate was 13.4 per cent. Those receiving irradiation alone have as good a yearly survival rate as those treated solely by operation.

No patients in Group III and IV can be said to be "cured." Careful analysis of the clinical and pathological criteria of these patients shows that most are incurable when first examined. Criteria for determining incurability of cancer of the breast are as follows:

#### Skin:

1. Edema (orange or pig skin) of more than slight extent.
2. Ulceration of more than slight extent.
3. Brawny red and inflamed, not obviously due to infection.
4. Multiple secondary nodules.

#### Breast:

1. Diffusely edematous.
2. Diffusely infiltrated.
3. Multiple secondary tumors.
4. Fixation to the chest wall.

#### Metastases:

1. Axillary lymph nodes numerous, extensively involved and fixed.
2. Supraclavicular lymph nodes or edema of arm.

3. Involvement of contralateral breast or lymph nodes.

4. Remote metastases in bones, lungs, or other viscera.

Some patients with these manifestations might be considered "operable," but all are "surgically incurable." There is little to justify subjecting these incurable cases to radical operation. They should be treated by irradiation alone, as just as many or more survive, their economic usefulness is prolonged, and they receive palliation. BERNARD S. KALAYJIAN, M.D.

**Carcinoma of the Larynx. Review of Treatment and End Results at the Brooklyn Cancer Institute.** W. E. Howes and M. Platau. *Arch. Otolaryng.* 40: 133-138, August 1944.

Of 68 men and 3 women with lesions proved to be carcinoma of the larynx who were admitted to the Brooklyn Cancer Institute from 1934 through 1942, 17 were still living at the time of this report. Of the surviving patients, 13 had intrinsic laryngeal carcinoma and 4 extrinsic carcinoma. The average age for the whole group was 58 1/2 years.

When the carcinoma is localized, operation offers the greatest opportunity for cure, and it is therefore the policy at the Institute to excise the growth when possible. Lesions too advanced for excision are usually referred for radiation therapy.

**Palliative Procedures:** Tracheotomy and gastrostomy are performed only for relief of symptoms and cannot therefore be considered as in any sense curative. Thirty-six patients underwent tracheotomy and 2 gastrostomy. Many of the tracheotomized patients were later treated with roentgen radiation.

**Surgical Treatment:** Four types of surgical treatment were carried through in this series: (a) electrocoagulation, (b) epiglottic resection, (c) laryngofissure, and (d) laryngectomy. Surgical procedures are performed on selected patients, which should give this group a certain advantage as to end-results.

Three patients received *electrocoagulation* directed to an extralaryngeal growth. Recurrence followed fulguration in each instance; subsequent roentgen therapy resulted in the survival of 1 in 3.

One patient, with the tumor arising in the extrinsic larynx, was treated by *epiglottic resection* and was living and well, without evidence of disease, at the time of this report.

*Laryngofissure* was performed on 9 patients with intrinsic cancer. One died of complications seven years after operation. Five were living at the time of the report; one of these received radiation therapy for recurrence.

*Laryngectomy* was performed on 5 patients. In each the cancer arose in the intrinsic larynx. Two patients were living without evidence of disease. Two patients received radiation in addition—1 radium, 1 roentgen rays. Neither of these survived.

**Curative Radiotherapy:** Both radium and roentgen rays have been used in the treatment of laryngeal carcinoma. Telerradium therapy requires large quantities of radium and at best is difficult because of the bulk and weight of the radium container. Radium can be applied interstitially in the form of needles or gold implants. Such insertion produces trauma to the part, however, and the evenness of the distribution of the sources of radiant energy is largely dependent on the



individual skill of the operator and the location and extent of the growth. Up to the present, none of the radium procedures appears to have any advantage over treatment with high-voltage roentgen rays, which the authors regard as the more efficient modality for irradiation. All patients treated in the Brooklyn Cancer Institute have received roentgen radiation, by a modified Coutard technic with repeated daily doses, calculated in the manner described by Howes and Bernstein (*Am. J. Roentgenol.* 50: 76-88, 1943).

Fifty-four patients in this series were given roentgen therapy, 43 of this number receiving a so-called therapeutic dose, *i.e.*, 4,875 r or more to the tumor in one continuous cycle of not over seven weeks' duration. The remaining 11 patients received various doses up to 4,875 r. Of the 43 patients given a therapeutic dose, 24 are listed as having a neoplasm that arose in the extrinsic larynx and 19 one that arose in the intrinsic larynx. Ten, or 23.25 per cent, of the 43 patients are living to date (February 1944).

Only carcinoma arising on the vocal cords (intrinsic) was observed to be amenable to surgical treatment in this series. Radiation therapy was shown to be of value both in carcinoma arising on the cords and carcinoma of the extrinsic structures of the larynx.

**Extramedullary Plasma Cell Tumor of the Mouth.** James R. Stancil and Wray J. Tomlinson. *Arch. Otolaryng.* 40: 139-141, August 1944.

An extramedullary plasma-cell tumor (plasmocytoma) of the mouth destroyed the uvula and part of the palate and involved the tonsils and tonsillar pillars in a 26-year-old Salvadorian mestizo. The lesion was grossly destructive and showed lateral extension but no anaplasia on microscopic examination. It was not suitable for excision, and roentgen therapy was instituted. Clinical extension ceased and local regression occurred, with healing. Treatment was divided into two series, with an interval of about a month. It consisted of a daily dose of 100 to 150 r in air given through two lateral cervical portals, each 10 × 10 cm. The factors were: 200 kilovolts (peak); 20 ma.; 50 cm. target-skin distance; 0.5 mm. copper and 1.0 mm. aluminum filtration. The total dose administered was 3,000 r in air to each portal. There had been no extension or recurrence of the growth in the nine-month period following the last treatment.

**Report of Case of Retroperitoneal Hemangioendothelioma.** T. J. Snodgrass. *Surgery* 15: 988-993, June 1944.

The case here reported is of interest because a diagnosis of sarcoma was made, but in the final examination the tumor proved to be of a much lower degree of malignancy.

The patient was a white female, aged 51 years, who was admitted because of fever, nervousness and fatigue, pain under the ribs on the left side, tenderness in the right lower quadrant, and pus cells in the urine. A tender mass was palpable halfway between the iliac crest and the lower ribs on the right. Immediately following hospitalization the leukocyte count varied from 14,000 to 19,000, the temperature ranged from 99.8 to 101.8° F., and the mass decreased in size daily. Five days later, however, it suddenly became larger and the leukocyte count increased. Exploration was undertaken and a huge retroperitoneal tumor was found extending down below the anterior iliac spine,

over the umbilicus, and up to the liver on the right. The tumor appeared hemorrhagic. A diagnosis of myxosarcoma or sympatheticoblastoma was made. The wound was packed and later closed. Frequent blood transfusions were required.

A retrograde pyelogram showed displacement of the kidney and ureter toward the mid-line, and a large indefinite mass was shown on a scout film. Following x-ray therapy (6,000 r) and administration of Coley's toxins, the patient's condition improved, with decrease in the size of the mass, an increase in hemoglobin, and a drop in the leukocyte count. X-ray examination a month later showed the tumor to be well encapsulated and of irregular density. It was outlined on intravenous urography, and a barium enema study showed displacement of the right hepatic flexure downward. It now appeared that surgical removal was possible. At operation the tumor was found to reach from below the crest of the ilium up almost to the costal margin and to be retroperitoneal. It appeared to be derived from the outer aspect of the right kidney. The postoperative diagnosis was probable hypernephroma.

Microscopic examination of the tumor showed it to be composed of numerous somewhat thick-walled blood vessels of arteriolar size, surrounded by cuboidal and cylindrical cells which appeared to arise from the vessel wall. Other vessels were of capillary size and still others were large and thick, containing areas of hyalinization and myxomatous changes. Neoplastic cells radiated from both the small and large vessels. The final diagnosis was retroperitoneal hemangio-endothelioma.

The patient left the hospital about six weeks later, and after another month was given a second series of x-ray treatments (3,600 r). Fourteen months after removal of the tumor, she was in good health and without evidence of recurrence.

The fever and leukocytosis observed in this case during the period of activity were probably the result of degenerative changes in the growth itself. With hemorrhage into the tumor there was a rapid drop of hemoglobin out of proportion to the blood loss. Response to radiation and Coley's toxins was sufficient to cause a regression of the tumor and, with it, a drop in the leukocyte count and an increase in the hemoglobin, but this response was not sufficient to give any assurance that complete regression would take place without excision. J. E. WHITELEATHER, M.D.

**Lymphoblastoma in Children Under Thirteen Years of Age.** Ira I. Kaplan. *J. Pediat.* 25: 155-160, August 1944.

Neoplasms in children are usually of the highly cellular type and therefore a preponderance of lymphomatous conditions is observed. Of the 27 children thirteen years and under with lymphoblastoma, referred to the Radiation Service of the Bellevue Hospital, 10 had leukemia, 11 Hodgkin's disease, and 6 lymphosarcoma. Although many Negro children are admitted to Bellevue Hospital, 25 patients in this series were white; there was 1 Negro and 1 Puerto Rican.

In 7 patients, the leukemia was of the lymphatic type; in 3, myelogenous. There were 6 boys and 4 girls in this group. The age of the youngest child was thirteen months and of the oldest six years. The blood count was indicative of the condition in all patients; the highest white cell count was 88,000. X-ray ther-

apy produced temporary relief in all patients. The longest known period of survival was four months after treatment.

The 11 patients with Hodgkin's disease were older than those with leukemia, the oldest being thirteen and the youngest eighteen months. Hypertrophied lymph nodes were the most common symptom. Roentgen examination showed chest involvement in 3 patients. Diagnosis in all cases was confirmed by biopsy. Treatment was by high-voltage x-rays, either to the involved node areas and/or to the chest; in some cases, to the spleen. Of the 11 patients, 7 are known to be dead.

All of the 6 patients with lymphosarcoma were under six years of age. Four were boys. Three had chest symptoms, 3 swellings of the neck. Biopsy proved the diagnosis in 5 cases. In one patient, death occurred during treatment. Even following autopsy, it was not decided in this case whether the correct diagnosis was leukemia or lymphosarcoma transformed into leukemia. In this group, 3 are known to be dead.

Although the results with radiotherapy in lymphoblastomatous conditions have not been favorable, no other method of treatment offers any more optimistic outlook. More gradual over-all irradiation, with greater attention to supportive therapy, may prove more successful. The toxemia following irradiation in small children is a serious sequel, not to be overlooked.

**Relationship Between the Lymphoblastic Tumor and the Digestive Tract.** J. Borak. *Am. J. Digest. Dis.* 11: 241-244, August 1944.

Lymphoblastic tumors are of two main varieties, lymphogranuloma (Hodgkin's disease) and lymphosarcoma. Both develop in the lymphatic tissue and may spread throughout the entire lymphatic system. The lymph nodes of some regions, as the neck and mediastinum, are invariably affected, while those along the digestive tract are less often involved.

The author has seen 8 cases in which enlarged lymph nodes along the digestive tract caused pressure symptoms. Five of the cases are described in this article. In all temporary relief from symptoms was afforded by deep therapy.

JOSEPH T. DANZER, M.D.

## NON-NEOPLASTIC CONDITIONS

**Radiation Therapy as a Method of Treatment in Non-Malignant Conditions.** Louis M. Piatt. *Ohio State M. J.* 40: 738-741, August 1944.

Some of the reasons for lack of wide acceptance of radiation therapy as a useful modality in the treatment of non-malignant diseases are the multiplicity of theories on the action of radiation in inflammation, the need for further understanding of the biological reactions, the inability of the patient to perceive any immediate beneficial effect, and the relatively high cost of these treatments. The author states Desjardins' theory that the clinical improvement following irradiation of inflammatory conditions is not due to direct bactericidal action but to production in the tissues of antibacterial endotoxins which destroy bacteria and aid healing (*Radiology* 29: 436, 1937). He also quotes Pendergrass and Hodges (*Am. J. Roentgenol.* 45: 74, 1941) as stating that in acute inflammation the response is due more to vascular changes induced than to destruction of leukocytes. No sharp dividing line between acute and chronic inflammation is available, though in the latter

fibrin deposit is less prominent and there is more lymphocytic infiltration and giant-cell formation. The unusual susceptibility of lymphocytes to radiation and the knowledge that it is these cells which are chiefly concerned in antitoxic activity explain much of the beneficial effect of radiotherapy in chronic inflammatory conditions. These changes cannot be duplicated in the test tube, and animal experimentation along these lines is not directly applicable to the treatment of human ills.

In bursitis, there is often an initial aggravation of symptoms after roentgen therapy, but beneficial effects follow in many cases and calcium deposits frequently disappear. Relief from pain is complete in 60 to 70 per cent and partial in 10 per cent; about 20 per cent receive no benefit. The author recommends 100 to 250 r at one- to three-day intervals.

In arthritis, before anatomic changes occur in bone and cartilage, marked relief of pain is frequently obtained—60 to 70 per cent of patients are greatly and 20 to 30 per cent slightly improved. Permanent bony deformities are not influenced. The author believes that radiation is particularly useful in Marie Strümpell spondylitis. Moderately filtered radiation in moderate dosage is recommended.

In the treatment of pneumonia, sulfonamides are of great value, but roentgen therapy may be used in those who do not tolerate the sulfa drugs or do not respond to them, in the aged, and in those with serious heart, liver and kidney disease. It should not be used simultaneously with chemotherapy. In virus pneumonia, the effect of roentgen therapy is often dramatic. One or two treatments of 50 to 100 r daily or every other day are recommended.

Several authorities are quoted as to the effectiveness of roentgen therapy in asthmatic conditions. Signal relief has been obtained in a high percentage of patients, and often better results in the more severe and protracted cases. The author recommends irradiation at 200 kv.p., with moderate filtration, through four to six portals.

In the treatment of sinus disease and other otolaryngological conditions, small doses are considered more effective in acute cases. Subacute cases respond best but need higher dosage. Results in children are excellent. Roentgen treatment of otitis media is also recommended. In cases with hypertrophy of lymphoid tissue about the eustachian tube, the alleviation of deafness is often excellent. The author urges discretion in the use of this modality in all these conditions and warns that it is not a panacea.

Hemorrhage at the climacteric without fibroids or cancer is frequently relieved by proper application of roentgen or radium therapy. Reduction in mortality and morbidity make these preferable to surgery in many cases. Radium therapy is easier to apply, requires less treatment time, produces less radiation sickness, and stops hemorrhage more quickly. However, roentgen treatment of the ovaries may also be needed. Many fibroids are reduced in size or disappear completely, but the larger ones should be handled surgically. Menopausal symptoms are less frequent than following surgical castration but more common than after hysterectomy without castration.

Many other lesions of non-malignant character are briefly mentioned as being benefited by radiation therapy.

BERNARD S. KALAYJIAN, M.D.



**X-Ray Treatment of Sinusitis.** Frederick T. Munson and Henry T. Munson. *Am. J. Surg.* 65: 95-97, July 1944.

In the authors' experience, small doses of roentgen radiation have been found to relieve pain in a high percentage of patients with acute sinus conditions, in some instances within four to six hours after the first treatment. Cases of acute sinusitis accompanied by pain and tenderness responded much more readily and dramatically than the chronic types of sinus inflammation. The following factors were used: 150 kv.p., 15 ma., 50 cm. skin-target distance, and a filter of 0.25 mm. Cu + 1 mm. Al. Treatments were given at intervals of two to six days, but usually at three-day intervals. The amount of radiation given at each treatment was either 100 or 150 r. Of the last 20 patients receiving x-ray therapy for acute sinus disease, 11 experienced immediate relief after one treatment, 4 after three treatments, while in 3 patients five or six treatments were necessary.

**Plasma Cell Mastitis. Report of Five Additional Cases.** Willard H. Parsons, John C. Henthorne, and R. Lee Clark, Jr. *Arch. Surg.* 49: 86-89, August 1944.

Though uncommon, plasma-cell mastitis is important because of its clinical resemblance to carcinoma of the breast. The characteristic feature is a painless unilateral tumor in a parous woman. Mild and evanescent signs of inflammation are present in the course of its development, and there may be a creamy discharge from the nipple. The lesion is not tender, and is often adherent to the skin so as to produce "orange-peel" dimpling. The nipple is frequently retracted, and the axillary lymph nodes may be enlarged. The gross lesion is a yellowish-brown discoloration of the mammary tissue, often with abscess formation. The contents of the abscess and adjacent ducts are puriform or buttery. Histologically there is ulceration of the duct epithelium with replacement by granulation tissue, formation of foreign-body giant cells, and periductal collection of plasma cells and other leukocytes. The clinical resemblance to carcinoma is so close as to lead to radical operation in most cases. The condition is thought to be due to inflammatory reaction to the lipid ductal contents.

In the discussion following this paper, Dr. R. L. Sanders suggests that, in view of the close histologic resemblance to comedo carcinoma, the lesion may well be precancerous. LEWIS G. JACOBS, M.D.

**Diabetes Insipidus. Clinical Observations in Forty-two Cases.** George M. Jones. *Arch. Int. Med.* 74: 81-93, August 1944.

In 34 of 42 cases of diabetes insipidus seen at the University Hospital (University of Michigan), the etiologic factors were clinically or pathologically determined. On the basis of this study, it is pointed out that diabetes insipidus is a symptom complex produced by injury to the supraopticohypophyseal tract, and not a specific entity. In any case of diabetes insipidus thorough and repeated examinations should be made to determine the etiologic factors. Urine concentration tests indicate that patients with diabetes insipidus receiving a limited fluid intake continue to secrete urine of low specific gravity, with resultant loss of body weight. In case in which such a response is obtained, the diagnosis of organic damage along the supraopticohypophyseal tract should be made.

Ideally, therapy in any case of diabetes insipidus should be directed toward the etiologic factor. Thus, in the presence of a neoplasm of the hypothalamus and pituitary or of Hand-Schüller-Christian disease, a good response to roentgen irradiation may be obtained, while antisyphilitic therapy corrects those cases resulting from syphilis. As diabetes insipidus is not infrequently the first symptom of a neoplasm, having occurred eight months and six years before other evidence of the malignant growth in 2 of the author's cases, a trial of roentgen irradiation of the hypothalamohypophyseal region may well be worth while when the cause of the diabetes is undetermined. Of 4 of the author's cases in which roentgen irradiation of the pituitary and hypothalamus was carried out because of neoplasm involving these regions, relief of the symptoms of diabetes insipidus was obtained in 3. The neoplasm in one case was apparently not radiosensitive. In 3 cases of Hand-Schüller-Christian disease (xanthomatosis) in which roentgen therapy was applied to the region of the pituitary, a good response was obtained in one case and a moderate response in another.

Of the various methods of administration of posterior pituitary substance as replacement therapy in the absence of the antidiuretic principle, intramuscular injection of pitressin tannate in oil seems the most desirable. Use of a low salt diet as an adjunct to other therapy may be worth a trial in any case of diabetes insipidus. Thyroidectomy should not be performed for diabetes insipidus unless there are other specific indications for the procedure.

**Radiotherapy of Ectopic Calcification.** E. Millington. *Brit. M. J.* 2: 148-149, July 29, 1944.

The author opens this short but pertinent article by expressing regret that the English surgeons fail to recognize the value of radiotherapy as completely as do the Americans.

The histology of ectopic calcifications is described and the rule offered that absorption can be caused by radiation only up to the time of new bone formation. The treatment recommended in subdeltoid bursitis consists of 200 r per week for four weeks, at 200 kv. with 0.5 mm. copper filter. The symptoms are relieved in six weeks, and changes are then apparent in the shadows on the x-ray film. Q. B. CORAY, M.D.

## EFFECTS OF IRRADIATION

**A Note on Irradiation Sickness.** William B. Bean, Tom D. Spies, and Richard W. Vilter. *Am. J. M. Sc.* 208: 46-54, July 1944.

Nausea, vomiting, headache, cramps, and diarrhea comprise the syndrome of irradiation sickness often complicating the course of therapeutic irradiation. From previous successful attempts at treatment of this illness with nicotinic acid, and with the discovery that the behavior of urinary pigments and the cohydrogenases I and II following irradiation over the spleen resembled that in severely ill pellagrins, it was planned to make a comprehensive examination of the effects of a standard dose of radiation. Normal well-fed subjects, those given a vitamin-deficient diet with and without some of the vitamins, pellagrins, and those whose poor diet had resulted in illness without specific deficiency stigmata were investigated.

The irradiation factors were: 200 kv., a Thoracur

filter, 20 ma., 20 cm. distance, 33 r per minute. The dose was 400 r over the upper abdomen and spleen.

Five normal subjects consuming a good diet or various vitamin B supplements showed no ill effects. Irradiation sickness occurred in varying degrees of severity in the rest of those studied, including the normal subjects who had subsisted on a vitamin B-deficient diet for six weeks. In all cases there was a rough correlation between the severity of the reaction and the degree of vitamin depletion as gauged clinically.

Once the illness was established, large doses of thiamine or nicotinic acid were of relatively little value. Irradiation sickness could be prevented or reduced in severity if the vitamin supplements were given for a few days before therapy was started.

A patient with myomata and carcinoma of the uterus suffered from severe irradiation sickness because of repeated doses of irradiation. She was not given supplements of vitamins, and subsequently pellagra and beriberi developed.

It would appear from these studies that the optimum time for vitamin therapy is before and not after irradiation sickness develops. The fact that patients needing radiotherapy often have a deranged nutrition makes careful dietary and vitamin therapy logical, if only on empiric grounds. BENJAMIN COPLEMAN, M.D.

**Effect of Roentgen Rays on the Minute Vessels of the Skin in Man.** Eugene P. Pendergrass, Philip J. Hodes, and J. Q. Griffith. *Am. J. Roentgenol.* 52: 123-127, August 1944.

The effect of roentgen rays on the minute vessels of the skin was studied by means of the capillary microscope. Areas of skin on the extensor surface of the forearm were selected, the opposite forearm being used as a control. Capillary counts were made before, six hours after, and twenty-four hours after irradiation. A final count was made after pricking the skin through a drop of 1:1,000 histamine to determine the total capillaries in the area under observation. The patients, 84 in number, were divided into four groups and the results were as follows:

In Group I (333 r in air delivered in 3/4 minute at 200 kv. (peak), 15 cm. target-skin distance) a significant dilating effect on the skin capillaries was observed after six hours and was largely gone after twenty-four hours.

In Group II (301 r in air delivered in 7.2 minutes at 200 kv. (peak), 50 cm. target-skin distance) a distinct dilating effect was observed six hours after exposure and was still present, but to a lesser degree, at the end of twenty-four hours.

In Group III (308 r delivered in 30.8 minutes at 200 kv. (peak), 50 cm. target-skin distance) there was no significant change seen in the skin capillaries after six hours and no very definite effect in twenty-four hours.

In Group IV (300 r delivered in 1 minute at 50 kv. (peak), 3 cm. target-skin distance) a moderate capillary effect was observed at the end of six hours, becoming more marked after twenty-four hours.

The responses of the subpapillary venous plexus to irradiation were also recorded. In Group III, which showed the least effect on the capillaries, there was the greatest effect upon the subpapillary venous plexus, but the reason for this was not clear.

The differences in the responses of the capillaries and venous plexuses seem related to the method of irradiation. L. W. PAUL, M.D.

**Rectal and Colonic Complications of Pelvic Irradiation.** Herbert I. Kallet and M. Jordan Thorstad. *Surgery* 15: 980-987, June 1944.

Following irradiation of the cervix or other pelvic organs, complications involving the rectum and lower colon may occur. These sequelae present serious and often perplexing diagnostic and therapeutic problems. Radiation therapy for carcinoma of pelvic organs is, however, an accepted procedure, and the serious nature of the original disease justifies the risk of subsequent complications. Before irradiation is recommended for benign conditions which are amenable to surgery, the question of secondary damage to the intestine must be carefully considered.

Injury to the connective tissue and blood vessels first exhibits itself in the form of edema. With further trauma, an endarteritis process develops, with thickening of the walls and gradual decrease in size of the lumen. Damage to the endothelial lining induces thrombosis and occlusion with infarct formation. The infarcted tissue is replaced by fibroblastic scar, which gradually undergoes sclerosis and hyalinization. Both striated and smooth muscle cells are also destroyed by heavy irradiation and are replaced by connective tissue.

The rectal and intestinal mucous membranes are very sensitive to the action of these destructive rays. Because of its anatomic proximity to the uterus, the lower intestine is within sharp radiation focus when the cervix is treated.

The complicated sclerosing process tends to progress as months go by. Hardening and shrinkage of the posterior pelvic and parametrial tissues take place. A firm mass may thus be formed below the uterocervical junction, which extends backward to the second and third sacral vertebrae. Ensnared in this fixed mass may be the vagina, the ureters, and the rectum. The vagina becomes stenosed and deformed, obstruction of the ureters may occur, and frequently stenosis of the rectum or sigmoid develops.

For convenience the sequelae may be grouped as follows:

1. Radiation proctosigmoiditis.
2. Entrapment.
3. Extension.
4. Fistula formation.

These may occur singly or in combination.

The most common intestinal complication following irradiation is *proctosigmoiditis*. This may vary in intensity from simple irritation to deep eschar formation. Symptoms may set in shortly after radium insertion, reaching maximum severity six or eight weeks later. There is diarrhea with increased mucus, the stools assuming a frothy character. Abdominal cramps and tenesmus are present, and the act of defecation gives incomplete relief. Scant amounts of blood may be found in the stool, but gross hemorrhage is uncommon. On digital exploration the sphincters will usually be found spastic. The proctoscopic picture varies with the degree of injury. Early, the mucosa appears edematous and much mucus will be seen. The membrane is hyperemic and easily traumatized. Later, with more severe involvement, patches of eschar will be visualized, yellow-white plaques sometimes an inch or more in diameter.

The condition is usually temporary. Treatment involves rest, both physical and mental; an adequate but non-irritating diet, and sedatives. The injection of

one of the oil-soluble anesthetics will relax sphincter spasm. Irrigations and colonic flushes may do more harm than good. Cod-liver oil, instilled once or twice daily, is soothing and seems to hasten resolution. Bismuth, kaolin and other drugs forming a protective bowel coating may at times be indicated. In favorable cases the reaction gradually subsides.

A serious sequel to irradiation is a stenosis of the sigmoid or upper rectum as the bowel is compressed by the firm fibrotic mass of the frozen pelvis. This *entrapment* takes place slowly over a period of months or even years, with the development of an intestinal obstruction of increasing severity. The stenosis is ordinarily palpable by digital examination. Occasionally it is only visualized by sigmoidoscopy or demonstrated by x-ray study.

The symptoms are those of increasing constipation; bowel movements may be preceded or accompanied by lower abdominal pain. The constipation is at length supplanted by a diarrhea of a paradoxical type, the patient having frequent small, unsatisfactory movements. The lack of appetite, anemia, loss of weight, vague pains, and abdominal distress in a patient known to have had a carcinoma are easily misinterpreted as an indication of metastasis. An early recognition of the benign nature of the stenosis changes the prognosis to a more favorable one.

Treatment depends upon the degree of stricture and the general condition of the patient. If the passage, though narrowed, is adequate, a low-residue diet and the regular administration of mineral oil may prove successful. When the obstruction is more severe, laparotomy must be done. Often colostomy must be performed.

Whenever rectal symptoms develop, the question at once arises; has extension or metastasis of the growth taken place? It is quite possible for the initial lesion in the cervix or elsewhere to resolve completely after irradiation and yet for invasion of the bowel wall to be present. The neoplasm may advance through the rectovaginal septum or extend laterally along the peritoneum of the posterior abdominal wall. In the latter instance, pain is generally a principal symptom. It is severe, neuralgic in character, radiating down the

left sciatic distribution. The pain in septal invasion is less intense.

Digital examination and sigmoidoscopy will usually differentiate a recurrence from the pseudocarcinoma brought about by inflammation and fibrosis. In recurrence the mass is more localized, it is raised and often polypoid, unlike the smoother stenosis of entrapment. Biopsy is, of course, the most accurate means of differentiation.

When recurring carcinoma is found, the radiologist must consider whether or not further irradiation is advisable. Here the possibility of factitial ulceration and the development of rectovaginal fistula becomes great. It is well in these recurrences to recommend colostomy early, both to avoid pain and to lessen the chance of fistula formation.

The development of *rectovaginal fistula* is a most distressing sequela. It may result from infarction brought about by destructive action of the radiation or as a result of secondary infection. The fistulas vary in size from pin-point openings to large defects. In small fistulas, relief may be secured by inducing constipation, the dry, formed stool being unable to leak through the perforation. Most patients with rectovaginal fistulas will require colostomy.

The author gives case reports illustrating each type of complication. J. E. WHITELEATHER, M.D.

**Radioactivity and Lung Cancer; A Critical Review of Lung Cancer in Miners of Schneeberg and Joachimsthal.** Egon Lorenz. J. Nat. Cancer Inst. 5: 1-13, August 1944.

The author reviews the studies of lung cancer in the miners of Schneeberg and Joachimsthal (see, for example, Pirchan and Šíkl: Am. J. Cancer 16: 681, 1932; Saupe: Fortschr. a. d. Geb. d. Röntgenstrahlen 60: 163, 1939) in the light of the experimental work of such investigators as Read and Mottram (Brit. J. Radiol. 12: 54, 1939) on the production or attempted production of lung tumors in mice. He concludes that the opinion that radon is the sole cause of lung cancer in these miners is not supported by the evidence at hand. A comprehensive bibliography is included.



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# RADIOLOGY

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## Tomography of the Skull<sup>1</sup>

ERVIN H. HOLVEY, M.D.,<sup>2</sup> and LOUIS M. ROSENTHAL, M.D.

Chicago Tumor Institute

and

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THE PURPOSE of this publication is to illustrate in detail the normal anatomical structures of the skull by tomographic roentgenograms. Comparison is made between these serial films and sections of a cadaver head at corresponding levels. In view of the increasing literature on tomography, as well as other methods, *i.e.*, laminagraphy, planigraphy, stratigraphy, etc., this study is necessary for the proper evaluation of roentgen appearances. Only by such a study will it be possible properly to understand and interpret variations from the normal demonstrated by tomography in pathologic states. Especially is this true of cancer.

### HISTORY OF TOMOGRAPHY

Body-section roentgenography is a relatively new science, having existed in practical usage since about 1930, gradually but steadily gaining new advocates. Bocage, in 1921, first applied for a French patent embodying the principles of this roentgenographic technic in an attempt to concentrate depth dosage in deep roentgen therapy. Portes and Chausse described a similar method in application for a French patent a few months later. No

practical use was made of these mechanisms, however, until Vallebona employed a method using stratigraphic principles. This proved unreliable and unsatisfactory, and in 1933 he developed the stratigraph which approximates closely other methods of body-section radiography in common use today. Ziedses des Plantes, in 1931, described a practical apparatus for body-section roentgenography and stated that he invented the method independently in 1921. Bartelink demonstrated his results with a similar apparatus at a meeting of the Association of Electrology and Roentgenology in Amsterdam.

Jean Kieffer in this country in 1929 patented an apparatus for body-section roentgenography which, with the assistance of Sherwood Moore, was constructed in 1934 and named the laminagraph. The laminagraph antedates the practical devices of Vallebona and Ziedses des Plantes and was probably the first practicable stratigraphic apparatus designed. Grossmann, meanwhile, described an apparatus which he named the tomograph, with which he was able to demonstrate clearly pulmonary abnormalities not well depicted by other radiographic means.

<sup>1</sup> Accepted for publication in June 1944. <sup>2</sup> Now Captain, M.C., A.U.S.

<sup>3</sup> Doctor Anson's contribution consisted of assistance in the identification of the anatomic structures shown in the illustrations.

The literature concerned with skull planigraphy is not extensive, but the works of Epstein, Moore, di Rienzo and Boher, and Froment and Buffé are noteworthy. Much attention, however, has been given to tomography of temporomandibular joint disorders, Peyrus and Aubert first pointing out the significance of this roentgenographic method.

Many authors have published articles concerning pulmonary tomography following Grossmann's pioneer work in 1935. Taylor, in 1938, presented an excellent review of cases seen at the Sea View Hospital.

Body-section roentgenography is especially valuable in examination of the skull, larynx, and thorax. In the former two fields its value is enhanced by ability to compare symmetrical halves as well as to obscure overlying and underlying bony structures which interfere with proper visualization in ordinary roentgenograms. In pulmonary roentgenography, it is often impossible otherwise to isolate pathologic processes because of opacities within the same parenchymal plane or because of superimposition of bony structures of the thoracic cage. In the study of spinal column abnormalities, also, these objections to standard radiographic procedures are eliminated.

Between 1936 and 1940, Leborgne in Uruguay and Canuyt and Gunsett in France demonstrated the value of this procedure in laryngeal cancer. Since then, Moore and his associates and Caulk have contributed to the subject. When Leborgne visited the United States in 1938, he assisted in the design and construction of a tomographic apparatus similar to one he had previously built in Uruguay. To our knowledge, this is the first apparatus of its type in this country. Caulk has adequately described it and again to detail its construction would be superfluous. Because of economy of operation and wide range of use, it is well suited to the needs of small institutions. Its value lies in the ability to obscure from a previously selected plane overlying and underlying bony

structures and soft tissues which in the ordinary roentgenogram would interfere with proper visualization of that particular region. While such films do not give distinct and detailed views of osseous architecture, they do furnish information not obtainable by ordinary roentgenography. By such means it is possible to follow a pathologic process from its point of origin to the area where it is lost in normal bony structure, thus obtaining a complete picture of the actual abnormality.

In our work, a cadaver head in relatively good state of preservation was used. This head was placed on the roentgenographic table in the postero-anterior position and, beginning at a point 3.5 cm. from the table top, tomograms were taken at 0.5-cm. levels through the entire skull. In a similar manner, another head was placed in the right lateral and then in the left lateral position and tomograms were taken at 0.5-cm. levels from 3.5 to 10.5 cm. from the table top in both instances. After successful postero-anterior and lateral tomographic films were obtained, the heads were sectioned, the first in the coronal and the second in the lateral planes, in an attempt to duplicate the tomographic levels. Because the saw itself removed some of the tissue in each bite and because there would be marked destruction and maceration of soft tissues in sections of such thin dimension, it was considered advisable to obtain the sections at approximately 2-cm. levels. In this way, comparisons could be made of the tomographic films which most closely approximated the anatomical levels obtained. Comparison of the coronal levels was made to a point just beyond the sphenoid sinuses, since it was found that for our purpose the films beyond this plane did not disclose anatomic structures of enough significance to justify detailed description. In addition, pathologic states within the cranial vault beyond this level could be isolated and visualized better by ordinary roentgenographic means than by postero-anterior tomography. Lateral tomography, however, does give valuable information concerning intracranial lesions.

In our tomographic descriptions we have attempted to use bony landmarks of the skull easy of identification, so that duplication of levels would be avoided as much as possible. In the postero-anterior projection, therefore, the fixed upper alveolar ridge is first used as an identifying structure; later, when sections beyond this level are visualized, the zygomatic arch and temporomandibular joint serve as guides. Since we cannot completely obscure the structures above and below our plane of tomographic motion, a certain thickness of tissues is included in each tomographic section so that in adjacent films it is possible to visualize structures which anatomically are located at a level above or below such plane. In such instances, however, these structures are not in critical focus and do not interfere appreciably with the proper evaluation of findings.

The radiographic factors for postero-anterior tomograms were as follows: kv.p. 65.2 to 74.2; 100 ma.; distance 40 inches; time 2 seconds; kv.p. increasing in inverse proportion to the distance from the table top. The following were the factors for the lateral tomograms: kv.p. 58.0 to 65.2; 100 ma.; distance 40 inches; time 2 seconds; kv.p. increasing as in postero-anterior tomography.

It may be stated that considerable variations in technic were attempted before the factors were found which best suited our needs. Also, because of the density of living tissue, the above factors must be varied slightly for diagnostic and radiographic usage. In our experience, elevation of the kv.p. has proved sufficient for obtaining good diagnostic films.

We wish here to thank Dr. James Irwin<sup>4</sup> for his aid in securing the factors of the radiographic technic.

#### INDEX OF LABELS

1. Alveolar process of maxilla
2. Maxillary sinuses
3. Orbit
4. Intramaxillary septum
5. "H" line
6. "R" line

7. Inferior concha
8. Ethmoidal air cells
9. Perpendicular plate of ethmoid
10. Nasal septum
11. Frontal sinuses
12. Supraorbital sinuses
13. Roof of orbit
14. Frontal process of zygoma
15. Zygomatic process of frontal bone
16. Middle concha
17. Zygomatic arch
18. Crista galli
19. Canine eminence of maxilla
20. Ascending ramus of the mandible
21. Palatine process of the maxilla
22. Lamina papyracea
23. Cribriform plate
24. Ostium of supraorbital sinus
25. Posterior ethmoidal air cells
26. Superior orbital fissure
27. Floor of infraorbital canal
28. Tongue
29. Inferior orbital wall
30. Infraorbital canal
31. Upper alveolar ridge
32. Coronoid process of mandible
33. Perpendicular plate of vomer
34. Osseous floor of anterior cranial fossa
35. Inferior orbital fissure
36. Palatine bone
37. Sphenoid sinus
38. Spur of sphenoid
39. Septum of sphenoid sinus
40. Greater wing of sphenoid
41. Styloid process
42. Optic foramen
43. Lesser wing of sphenoid bone
44. Condylod process of the mandible
45. Neck of condylod process of mandible
46. Superior concha
47. Temporomandibular joint
48. Angle of mandible
49. Mastoid process
50. Squamous portion of temporal bone
51. Parietal bone
52. Zygoma
53. Maxilla
54. Tubercle at the root of zygomatic process of temporal bone (marginal tubercle of zygoma)
55. Mandibular notch
56. Middle cranial fossa
57. Petrous portion of temporal bone
58. Linear shadow cast by curving surface of zygoma
59. Zygomatico-frontal suture line
60. Posterolateral orbital wall
61. Anterior cranial fossa (34)
62. Posterior cranial fossa
63. Auditory canal
64. Cerebellum

<sup>4</sup> Trainee, National Cancer Institute.



65. Tentorium cerebelli
66. Orbital plate of maxilla
67. Anterior clinoid process
68. Spine of sphenoid bone
69. Occiput
70. Lateral pterygoid plate
71. Premaxilla<sup>5</sup>
72. Pterygo-maxillary fissure
73. Body of sphenoid bone
74. Medial pterygoid plate
75. Horizontal plate of palatine bone
76. Soft palate
77. Sella turcica
78. Dorsum sellae
79. Palatine process of maxillary bone
80. Perpendicular plate of palatine bone
81. Basi-occiput
82. Foramen magnum
83. Uvula
84. Nasal bone
85. Spinal cord
86. Laryngeal part of pharynx (hypopharynx)
87. Nasopharynx
  - A. Falx cerebri
  - B. Air in ventricle

#### POSTERO-ANTERIOR ANATOMICO-TOMOGRAPHIC STUDY

The following is a detailed description of the postero-anterior tomographic levels of the skull. For the views which most closely approximate the anatomical sections, the latter are inserted for comparison of anatomic landmarks visible on both. By such comparison it is possible to determine how correct we are in the evaluation of roentgen shadows in tomography. Changes in the morphology, as well as appearance of structures as they appear in focal view, will be noted.

Figure 1 is a tomogram at the level of the upper central incisor teeth. The lower central and lateral incisors are also in good focus, and the line of the symphysis menti is shown. The depression in the left mandible at the mental foramen is also seen, as is the left mandibular ramus. The alveolar process of the maxilla, 1, is represented by the most dense shadow on this film. Both maxillary sinuses, 2, are just coming into view. They are seen as small areas of rather indefinite outline impinging on the medial and inferior walls of each

orbit, 3. Septa, 4, are clearly depicted within both of these atria.

In this film a vertical linear shadow is apparent, arising from the lateral border of each maxilla and extending superiorly to bisect each maxillary sinus. This density, noted in a previous publication, represents a shadow cast by the posterolateral wall of the maxilla and is arbitrarily called the "H" line, 5. This linear shadow, as will be seen in later tomograms, continues cephalad and medially to form the inferior border of the inferior orbital fissure. At such level, the "H" line represents the point of junction of the posterolateral wall and the orbital plate of the maxillary bone. A similar shadow just appearing in view behind the lateral third of the right orbit is cast by the lateral portion of the frontal bone, squamous portion of the temporal bone, and in most part by the greater wing of the sphenoid bone. This line has been arbitrarily called the "R" line, 6. In later films we note that this line curves abruptly medially and upward to parallel the "H" line and form the superior border of the inferior orbital fissure. At this level the "R" line represents the line of junction between the greater wing of sphenoid and the orbital plate of that bone. At such levels, therefore, these lines are both more apparent and important.

The nasal cavity is clearly outlined, and the inferior conchae, 7, are just coming into view, delineating a clear inferior meatus. The middle conchae are not yet seen, but several anterior ethmoid air cells, 8, can be visualized, as well as the perpendicular plate of the ethmoid bone, 9. The nasal septum, 10, is in good focus. Both orbital cavities, 3, are well outlined and are large and elliptical. It is possible to see the superimposed soft-tissue shadows of both upper and lower eyelids.

The faint representations of the frontal sinuses, 11, are fading from view, since the tomographic level is beyond these air cells. The supraorbital sinuses, 12, however, are clearly outlined. Embryologically these cells are a lateral projection of the anterior and middle ethmoid cells and pneumatize

<sup>5</sup> Cunningham's Textbook of Anatomy. Oxford University Press, Seventh Edition, 1937, p. 218.

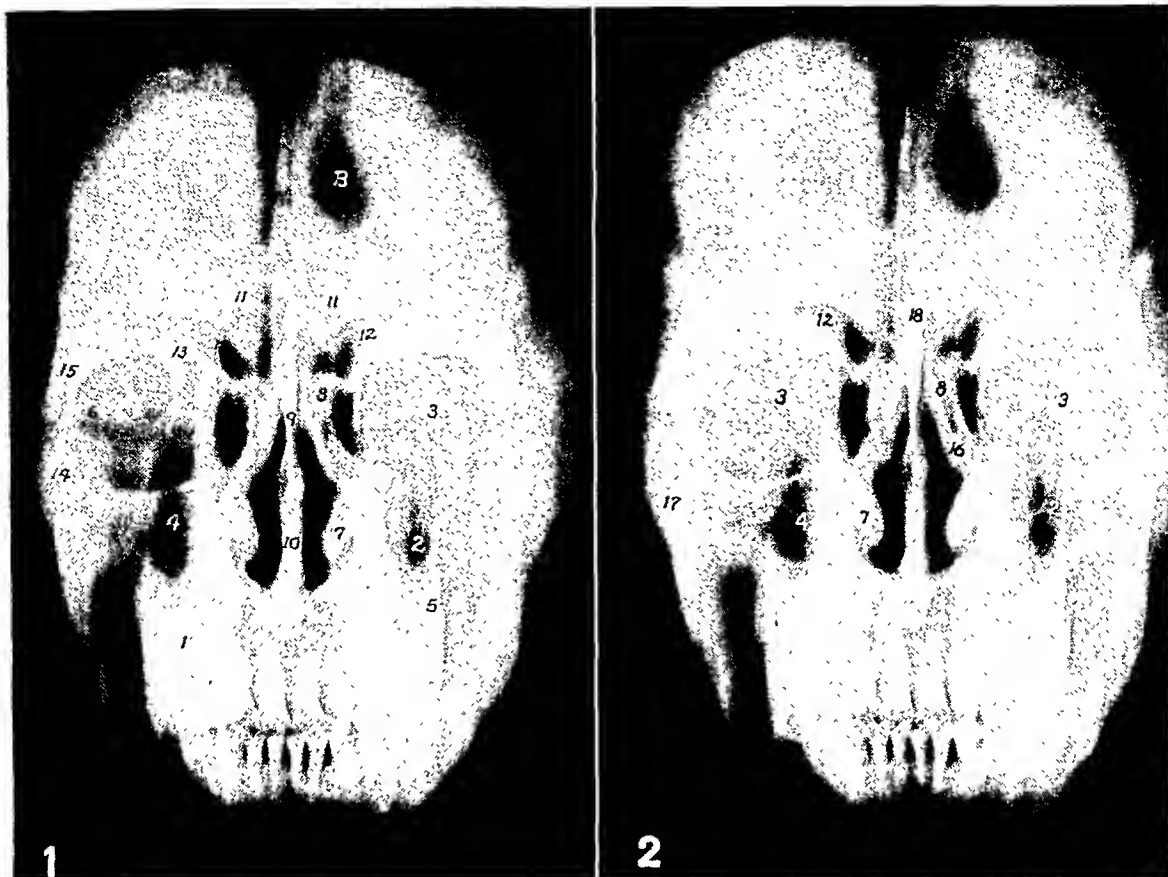


Fig. 1. Coronal section at level of upper central incisor teeth. 1. Alveolar process of maxilla. 2. Maxillary sinus. 3. Orbit. 4. Intramaxillary septum. 5. "H" line. 6. "R" line. 7. Inferior concha. 8. Ethmoidal air cells. 9. Perpendicular plate of ethmoid. 10. Nasal septum. 11. Frontal sinuses. 12. Supra-orbital sinuses. 13. Roof of orbit. 14. Frontal process of zygoma. 15. Zygomatic process of frontal bone. A. Falx cerebri. B. Air in ventricle.

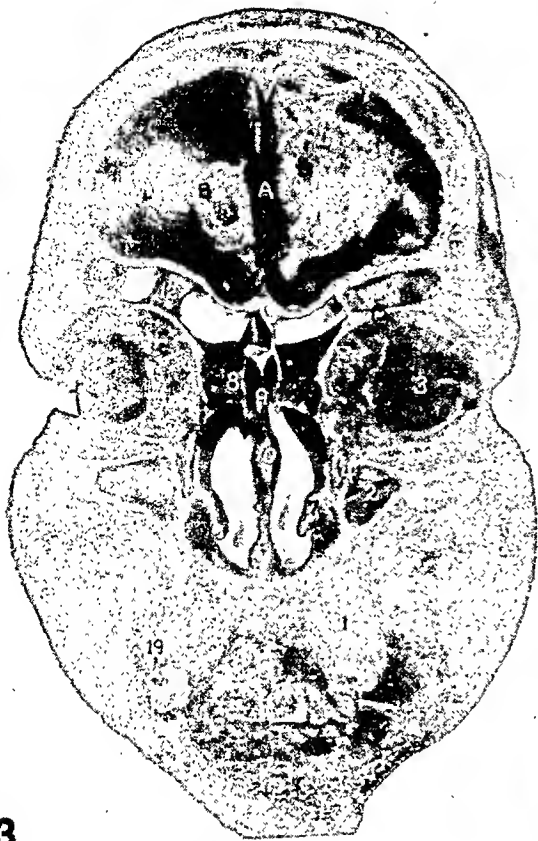
Fig. 2. Coronal section at level of upper lateral incisor teeth. 16. Middle concha. 17. Zygomatic arch. 18. Crista galli.

that portion of the frontal bone just posterior to the frontal sinuses and overlying the orbit. Anatomically this explanation is debatable. It is the opinion of some anatomists that, while in the majority of instances the above holds true, there are many examples in which these supra-orbital cells quite definitely represent a posterior pneumatization of frontal and sometimes anterior sphenoid bones by the frontal sinus. (Poor results in surgical procedures upon the frontal sinuses are frequently attributed by rhinologists to these cells, because of their inaccessibility and drainage through parent structures, in the case of ethmoid pneumatization.) The roof of each orbit, 13, lying between the orbital cavity and the supraorbital sinus

is particularly well seen. The thin wall between these structures is manifest. The frontal process of the zygoma, 14, and its junction with the zygomatic process of the frontal bone, 15, is clear, especially on the right.

Because the skull is that of a cadaver, it had been exposed for some time to air and had lost much of its fluid content. We are therefore able to delineate the anterior cornua of both lateral ventricles, B, the falx cerebri, A, and actual brain substance. (These structures are ordinarily not demonstrable by this radiographic technic.)

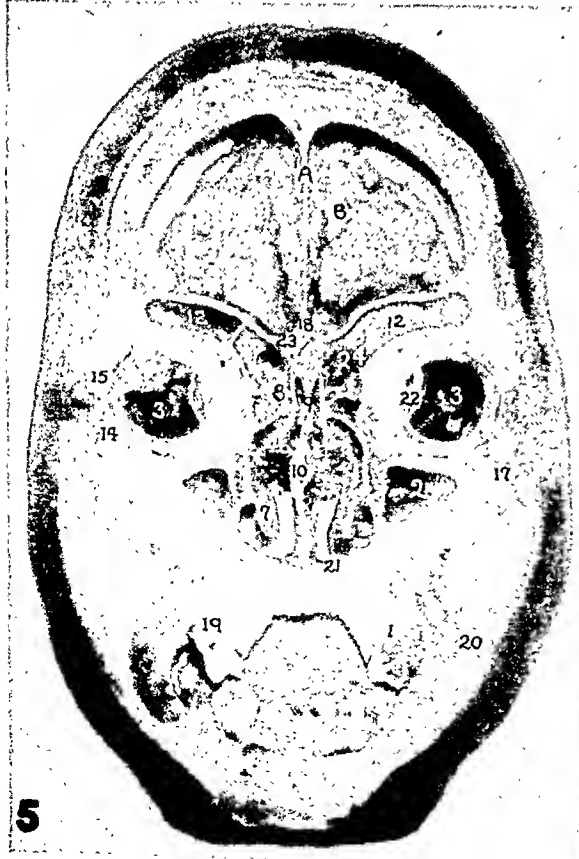
The next tomographic level, Figure 2, is at the plane of the upper lateral incisor teeth. Here the inferior conchae, 7, are



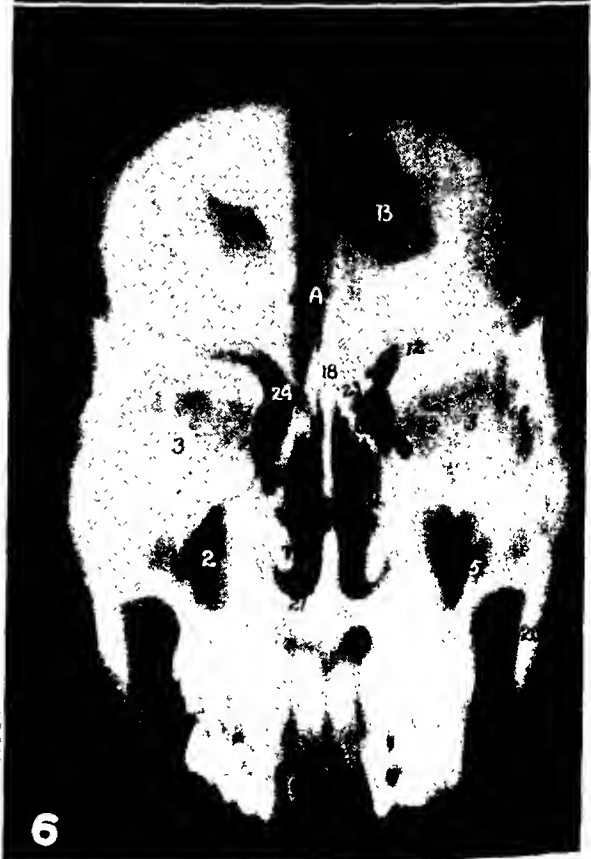
3



4



5



6

Figures 3-6

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clearer and larger, and the origins of the middle conchae, 16, are just visible. The maxillary atria, 2, are more definite and triangular, and pneumatization of the zygomatic arch of the maxilla of either side is discernible. Septa, 4, are very clear within these cells. The inferior border of the zygomatic arch, 17, is coming into relief. The orbital cavities, 3, are slightly larger than in the previous tomogram and slightly more spherical in outline. The ethmoid sinuses, 8, bilaterally are in clearer detail, and the supraorbital cells, 12, are in better focus and their lateral extension is demonstrable. The crista galli, 18, is visible. The "H" and "R" lines show no great variation from Figure 1. No other significant changes in the osseous structure are noted.

Figures 3 and 4 are of relatively comparable anatomic and tomographic levels, although the former is slightly anterior to the roentgenographic plane and is really a composite of the second and third tomographic levels. The roentgenogram and anatomic cuts are at the level of the canine teeth bilaterally and define the canine eminence of the maxilla, 19, well. The section is at the most prominent portion of the inferior conchae, 7, and the tomogram reveals a slight increase in size of the shadow of the middle concha, 16, although this structure is absent in the specimen.

At the anatomic level, the maxillary sinuses, 2, are still triangular, even though in the tomogram they assume a more rhomboidal configuration. Orbits, 3, in both views are large and spherical; the nasal septum, 10, is well delineated, as are the ethmoid air cells, 8. The supraorbital sinuses, 12, are in sharp focus and their form is almost duplicated in the two views.

The margins of the orbital roofs, 13, so clearly visualized in Figure 2, are now blurring because of the curvature of the superior orbital plates. Since the "H" and "R" lines represent osseous planes accentuated by tomographic technic, they are not directly applicable to the anatomic sections. In the roentgenogram they are noted in clearer detail than previously, especially on the left side.

As Figure 3 represents an anatomic level just beyond the second, and anterior to the third tomographic plane, so Figure 5 represents an anatomic level just posterior to the latter plane, disclosing comparable anatomic structures. The configuration of the maxillary, supraorbital, and ethmoid sinuses is similar, the orbital cavities are of size and shape corresponding to the tomographic level shown in Figure 4, and the limiting walls of both maxillary antra are distinct and comparable. As in the tomogram, the most anterior portion of the middle concha is making its appearance. The inferior conchae and the septum are distinct and conspicuous.

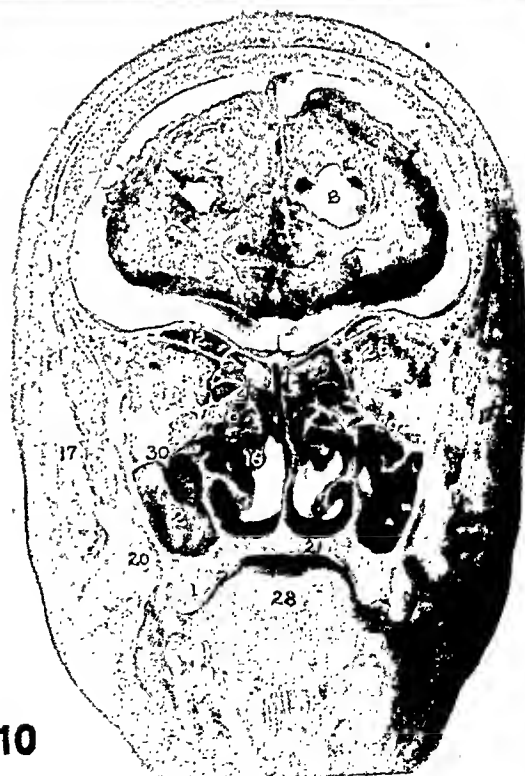
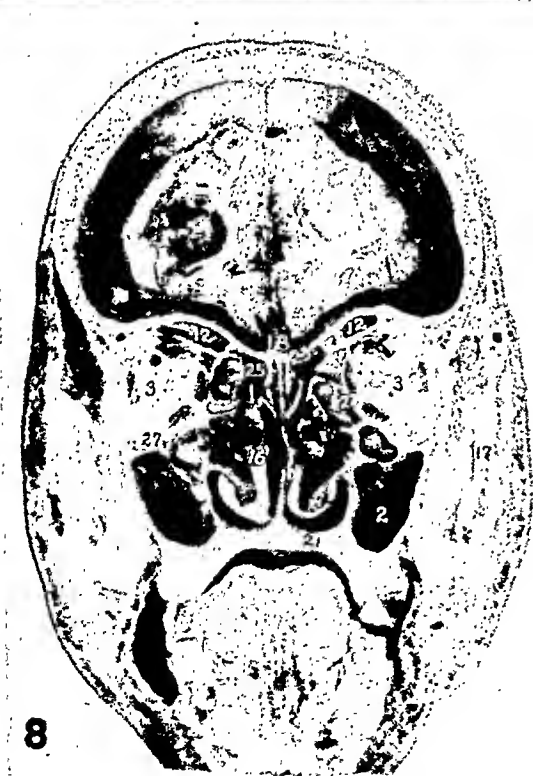
In Figure 6, we are now 5 cm. from the roentgenographic table top. This tomogram is at the level of the first bicuspid teeth bilaterally. Both maxillary sinuses, 2, are excellently defined, the lateral pneumatization of the zygomatic arches being particularly well delineated. The walls of the sinuses appear in sharp detail, and the orbital and inferior maxillary osseous structures are well demonstrated. At this level the ascending rami of the mandible, 20, are seen. The inferior conchae, 7, are still well defined and the downward projections of both middle conchae, 16, can be visualized. The palatine processes of the maxillae, 21, are also well seen. At

Fig. 3. Anatomic coronal section at level of upper canine teeth. 2. Maxillary sinus. 3. Orbit. 7. Inferior concha. 8. Ethmoidal air cells. 10. Nasal septum. 12. Supraorbital sinus. 13. Roof of orbit. 19. Canine eminence of maxilla.

Fig. 4. Coronal section at level of upper canine teeth. 19. Canine eminence of maxilla. "H" and "R" lines are in clearer detail, especially on the left side (5 and 6).

Fig. 5. Anatomic coronal section at level of upper first bicuspid teeth. 2. Maxillary sinus. 3. Orbital cavities. 7. Inferior concha. 8. Ethmoidal air cells. 12. Supraorbital sinuses. 16. Middle concha. 18. Crista galli. 20. Ascending ramus of mandible. 21. Palatine process of maxilla. 22. Lamina papyracea. 23. Cribriform plate. 24. Ostium of supraorbital sinus. A. Falx cerebri. B. Air in ventricle.

Fig. 6. Coronal section at level of upper first bicuspid teeth. 20. Ascending ramus of mandible. 21. Palatine process of maxilla. 22. Lamina papyracea. 23. Cribriform plate. 24. Ostium of supraorbital sinus.



Figures 7-10

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this plane the orbital cavities, 3, appear slightly smaller than in previous tomograms but are more spherical in outline. The lamina papyracea, 22, of the medial orbital wall, laterally bounding the ethmoidal air cells, 8, is seen in distinct detail. The ethmoidal sinuses, 8, are in good focus and the cribriform plate, 23, is shown. The crista galli, 18, is fading from view. The supraorbital sinuses, 12, are now smaller than in previous views and do not extend so far laterally. What is probably an orifice, 24, from these sinuses into the ethmoid cells is seen on either side. The falx cerebri, A, and the air-filled anterior horns, B, of both lateral ventricles are well defined. The "H" and "R" lines are becoming more prominent and are gradually and progressively approximating each other. This is especially obvious on the left side.

Figures 7 and 8 represent corresponding roentgenographic and anatomic levels. Certain changes in the shape of structures previously observed are apparent. The level of these "sections" is at the approximate coronal plane of the second bicuspid bilaterally. The crista galli, 18, is fading from view, and the cribriform plate, 23, of the ethmoid is very distinct. The supraorbital sinuses, 12, are smaller and narrower and we are now beginning to see the posterior ethmoid air cells, 25. The middle nasal conchae, 16, are very well delineated, while the inferior conchae, 7, are receding from sharp focus. The orbital cavities, 3, are becoming smaller and assuming a triangular shape. The lamina papyracea, 22, is still fairly well defined on the left side on the tomographic view. The beginning of the superior orbital fissure, 26, is seen in the superior portion of the right orbit

on this film. The inferior orbital fissure in our study has never been well shown by posterior-anterior tomography. The maxillary sinuses, 2, are smaller at this level and becoming triangular. In the superior portion of each of these atria is a small, wedge-shaped projection directed at the lumen of the sinus. It is felt that these osseous structures in the roentgenograms represent the floors of each of the infraorbital canals, 27. The inferior wall of each maxilla is distinct to view, and its projection into the zygoma is demonstrated, as well as the clearly evident border of the lateral zygomatic arch, 17. The "H" and "R" lines in the roentgenogram are approximating each other more closely on the left side and are more clearly visualized on the right side of the skull.

Figure 9 shows the next tomographic level, at the plane of the alveolar ridge between the bicuspid and first molar teeth, and Figure 10 represents approximately the same anatomic level of the sectioned skull. While it is possible to distinguish the beginning appearance of tongue substance, 28, in Figure 7, it is in this tomographic film (Fig. 9) that its outline is definite and well formed. The ascending ramus of the mandible, 20, on the left is still visible on the roentgenogram. The maxillary sinuses, 2, are smaller than on the previous roentgenogram, but their medial portions are elongated; they extend upward to the level of the middle ethmoid air cells, 8, and their excursion inferiorly carries them well into the alveolar ridge. The lateral extension of both atria into zygomatic arch, 17, is not so pronounced. The thin wall of the orbit inferiorly, 29, is well defined in both sections. (It is easy to understand, from these views why interorbital

Fig. 7. Coronal section at level of upper second bicuspid teeth. 25. Posterior ethmoidal air cells. 26. Superior orbital fissure. 27. Floor of infraorbital canal.

Fig. 8. Anatomic coronal section at level of second bicuspid teeth. 2. Maxillary sinus. 3. Orbital cavities. 12. Supraorbital sinuses. 16. Middle concha. 17. Zygomatic arch. 18. Crista galli. 22. Lamina papyracea. 23. Cribriform plate. 25. Posterior ethmoidal air cells. 26. Superior orbital fissure. 27. Floor of infraorbital canal.

Fig. 9. Coronal section at level of upper alveolar ridge between bicuspid and first molar teeth. 28. Tongue. 29. Inferior orbital wall. 30. Infraorbital canal.

Fig. 10. Anatomic coronal section at level of upper alveolar ridge between bicuspid and first molar teeth. 2. Maxillary sinus. 3. Orbit. 7. Inferior concha. 8. Ethmoidal air cells. 12. Supraorbital sinus. 16. Middle concha. 17. Zygomatic arch. 20. Ascending ramus of mandible. 25. Posterior ethmoidal air cells. 26. Superior orbital fissure. 28. Tongue. 29. Inferior orbital wall. 30. Infraorbital canal.



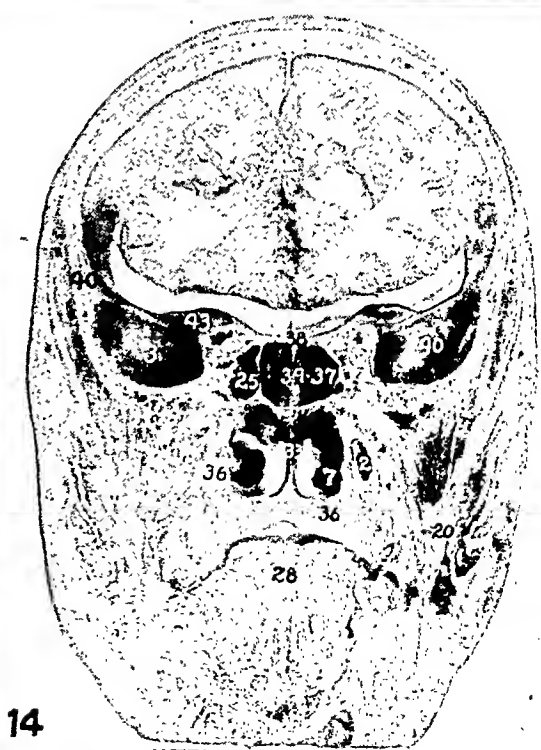
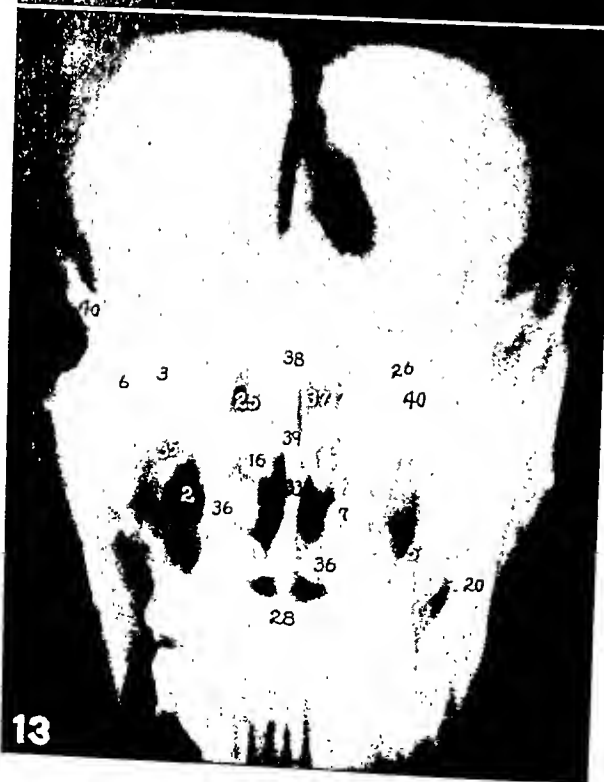
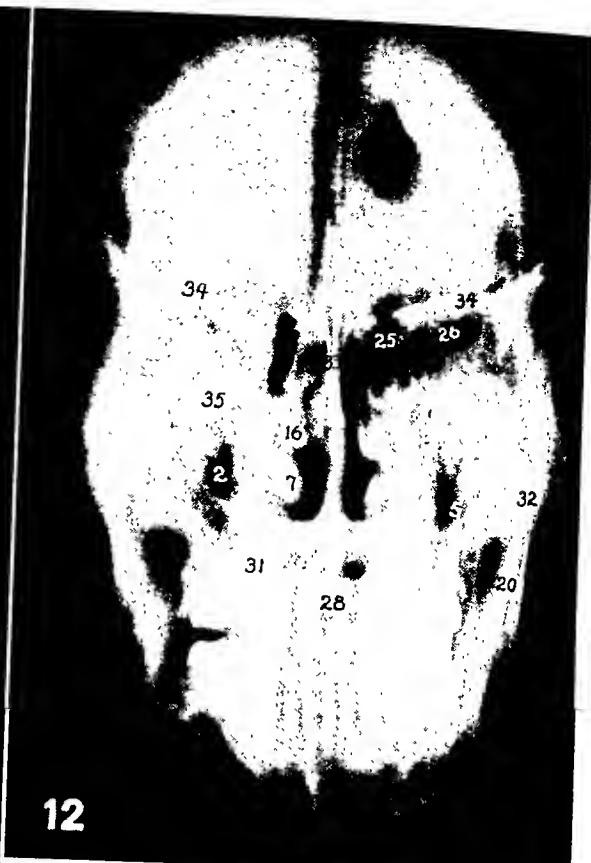
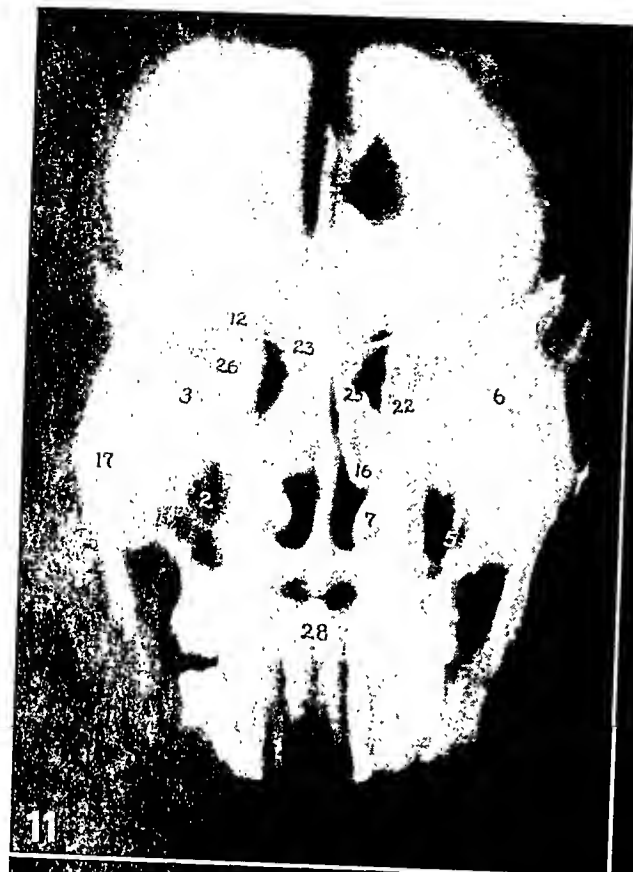


Fig. 11. Coronal section at level of first upper molar teeth.

Fig. 12. Coronal section at level of second upper molar teeth. 31. Upper alveolar ridge. 32. Coronoid process of mandible. 33. Perpendicular plate of vomer. 34. Osseous floor of anterior cranial fossa. 35. Inferior orbital fissure.

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extension of antral cancer is not an infrequent occurrence.) The infraorbital canals, 30, are both visualized in the tomogram, while that on the right side is seen in the anatomic section. Both inferior, 7, and middle conchae, 16, are excellently detailed, the latter being more prominent than in any previous film.

The orbital cavities, 3, are smaller and less spherical, assuming a pyramidal shape, their bases being directed medially and inferiorly. The ethmoid sinuses, 8, are well depicted, both middle and posterior cells, 25, appearing in view in Figures 9 and 10. The supraorbital sinuses, 12, are still smaller, that on the left being almost completely beyond the tomographic level. Good duplication of these structures is noted in the anatomic view. The crista galli is barely visible in both views. Both superior orbital fissures, 26, are seen. The brain substance and lateral ventricles are also shown. The "H" and "R" lines, 5 and 6, are very prominent on the left and quite well seen on the right side of the skull. Medial and superior curvature of the "R" line to form the superior border of the inferior orbital fissure is seen.

In Figure 11, the next tomographic level, we are at the coronal plane of the first upper molar tooth. Tongue substance, 28, is well defined and, in the nasal cavity, inferior, 7, and medial conchae, 16, are receding from focus. This level is through the posterior portion of both maxillary antra, 2, and the pneumatization of zygomatic arch, 17, is less evident than in previous films. The margins of maxillary and zygomatic bones inferiorly and laterally are less distinct. The maxillary sinus, 2, on the right is small and circular, while that on the left is narrow and elongated from above downward. Within the nasal cavity the middle, 16, and inferior conchae, 7, are smaller. The ethmoidal sinuses are

well demonstrated, and the posterior cells, 25, of this structure are in clearer detail and are larger. The supraorbital sinus, 12, on the left has completely disappeared, while on the right there is a remnant of the large well-formed structure seen previously. The cribriform plate, 23, of the ethmoid is still in view.

The orbital cavities, 3, are smaller and almost triangular. The lamina papyracea, 22, is still well seen. The superior orbital fissure, 26, on each side is excellently detailed. The curvature of each greater wing of the sphenoid bone, which forms the walls of both the superior and inferior orbital fissures, is noted bilaterally. The "H" and "R" lines appear well defined and are approximating each other on the left side.

Figure 12, the next tomographic level, is approximately at the plane of the second upper molar tooth. The tongue, 28, is well defined, as are the upper alveolar ridges, 31, bilaterally. The ascending ramus, 20, of the left mandible is visualized, as is its coronoid process, 32. Both maxillary sinuses, 2, are small, and that of the left side of the skull is assuming a spherical outline. The conchae bilaterally are smaller, and the middle ethmoid air cells are being lost to view, while the posterior ethmoid sinuses, 25 (larger and more clearly defined cavities than either anterior or middle groups), are becoming more prominent. The anterior portion of the vomer (perpendicular plate), 33, is now visualized at the superior portion of the nasal septum. The remnant of the right supraorbital sinus, 12, is still seen. The orbital cavities 3, are still triangular, but narrow and elongated horizontally. The osseous floor of the anterior cranial fossa, 34, is well seen, and a tiny spur of the crista galli remains in view. Superior, 26, and inferior, 35, orbital fissures are observed bilaterally, especially the former, and it is possible to

Fig. 13. Coronal section at level of last upper molar teeth. 36. Palatine bone. 37. Sphenoid sinus. 38. Spur of sphenoid. 39. Septum of sphenoid sinus. 40. Greater wing of sphenoid.

Fig. 14. Anatomic coronal section at level of last upper molar teeth. 2. Maxillary sinus. 3. Orbital cavity. 7. Inferior concha. 16. Middle concha. 20. Ascending ramus of mandible. 25. Posterior ethmoidal air cells. 28. Tongue. 33. Perpendicular plate of vomer. 36. Palatine bone. 37. Sphenoid sinus. 38. Spur of sphenoid. 39. Septum of sphenoid sinus. 40. Greater wing of sphenoid bone. 43. Lesser wing of sphenoid bone.



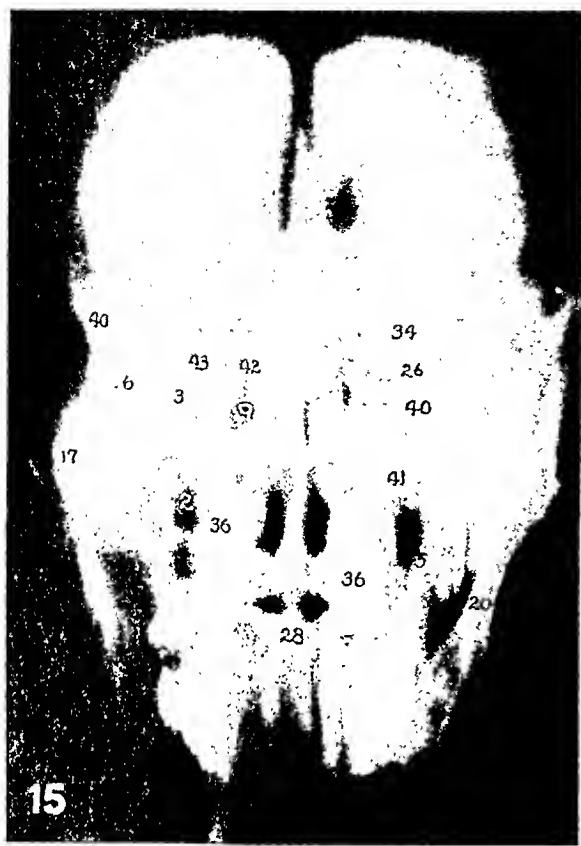


Fig. 15. Coronal section at level of posterior portion of last molar tooth. 41. Styloid process. 42. Optic foramen. 43. Lesser wing of sphenoid bone.

demonstrate the medial and superior curvature of the "R" line, 6, bilaterally, forming the roof of the latter fissure.

In Figures 13 and 14 the coronal plane is at the last upper molar level. The ascending ramus, 20, of the left mandible is still shown on the tomogram, but the coronoid process is not in focus. Palatine bones, 36, are evident in both views, and it is possible to see that they do not quite reach the mid-line in the roentgen film. Because it is impossible to obscure adjacent structures completely, we see remnants of the maxillary sinuses, 2, bilaterally in the tomogram, while a small portion of the left antrum is apparent in the anatomic section. The posterior portion of middle, 16, and inferior conchae, 7, are almost duplicated in these views, as well as the mid-portion of the vomer, 33. The septal cartilage is well seen. At this level we have our first view of the sphenoid sinuses, 37, all the walls of which are clear. (In this

particular skull, an anomalous posterior ethmoid cell, 25, on the right compresses the sphenoid cell on that side. This is not a rare occurrence, and at times such an anomalous sinus may almost completely replace the sphenoid cell posterior to it by posterior expansion and pneumatization.) A tiny spur, 38, on the sphenoidal crest is noted in the anatomical and roentgen views. The septum of the sphenoid sinus, 39, as well as the wall forming the nasal roof, is well depicted. The supraorbital sinuses, except for an almost negligible remnant on the right side, have disappeared from view. The orbital cavities, 3, at this level are narrow and elongated horizontally. In both figures it is possible to distinguish the superior orbital fissures, 26. The inferior orbital fissure, 35, is fairly visualized in the tomogram. Also in this roentgenogram the "H," 5, and "R," 6, lines are clear and on the left side we are able to trace them both as they proceed medially and upward to bound the inferior orbital fissure. This delineation is not so clear on the opposite side of the skull. The curvature of the greater wing of the sphenoid, 40, is noted on both sides as it forms the boundary of separation between these fissures. The lesser wings of the sphenoid, 43, are better seen in the anatomical section than in the tomogram.

The next tomographic view, Figure 15, is at the level of the posterior portion of the last molar tooth of the right upper alveolar ridge. On the left side of the skull we are slightly beyond this level. Tongue, 28, substance is still visible, and the palatine bone, 36, is seen bilaterally. This section is beyond the level of the maxillary sinus, 2, on the left side and only a small circular remnant of that on the right side of the skull is noted. The inferior and middle conchae are still demonstrable, but they, too, are receding from focus. On the left side of the skull the tip of the styloid process, 41, is making its appearance, between the ascending ramus, 20, of the mandible and the lateral wall of the maxilla. Both orbital cavities are flattening and, although the superior orbital fissures can still be seen,

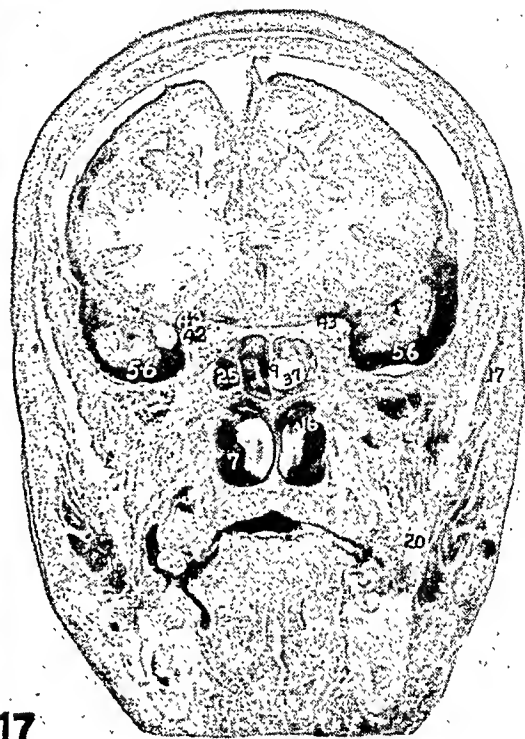


Fig. 16. Coronal section at level of most posterior portion of upper alveolar ridge.

Fig. 17. Anatomic coronal section at level of the most posterior portion of the upper alveolar ridge. 7. Inferior concha. 16. Middle concha. 17. Zygomatic arch. 20. Ascending ramus of mandible. 25. Posterior ethmoidal air cell. 37. Sphenoid sinus. 42. Optic foramen. 43. Lesser wing of sphenoid bone. 56. Middle cranial fossa.

the "H" and "R" lines are becoming less prominent, and the inferior orbital fissure is out of focus.

The sphenoid sinus is well delineated and the anomalous right posterior ethmoid cell, 25 (erroneously numbered 9 in the figure), is very clear. Just above the lateral edges of each sphenoid sinus we are now able to visualize the optic foramina, 42. Both greater, 40, and lesser wings, 43, of the sphenoid are seen and the floor of the anterior cranial fossa, 34, is shown. The prominent spread of the zygomatic arch, 17, on both the right and the left side is becoming evident.

In Figures 16 and 17, comparable tomographic and anatomic views, the coronal plane is at the level of the most posterior portion of the upper alveolar ridge bilaterally, that on the right side including the last portion of the third molar tooth. This level also includes, in this particular skull, the most posterior portion of the lower

alveolar ridge, at the level of the last molars. On the tomographic film it is possible to distinguish the ascending rami, 20, of both mandibles as they are coming into view. In this film, also, we can see the small remnant of the right maxillary sinus as well as the fading shadow of that on the left. In the anatomic section, we are beyond this osseous level. (The angle at which the anatomic sections were cut does not exactly coincide with the tomographic levels, so that, as we proceed superiorly, the anatomic sections are deeper than those seen stratigraphically. This difference in level is more apparent as we approach the plane of the lesser wing, 43, of the sphenoid and proceed just beyond it into the middle cranial fossa, 56.) In both views, however, we notice the remnants of both the middle, 16, and inferior conchae, 7. The sections are now beyond the mid-portion of the sphenoid sinuses, 37, and the walls are slightly blurred due to the curva-



Fig. 18. Coronal section at level of mid-portion of zygomatic arch. 44. Condylod process of mandible. 45. Neck of condylod process of mandible. 46. Superior concha.

Fig. 19. Coronal section at level of widest portion of zygomatic arch. 17. Zygomatic arch. 44. Condylod process of the mandible. 47. Temporomandibular joint.

ture of the posterior osseous limits. The posterior ethmoid cell, 25, on the right is still in excellent view. The optic foramen, 42, can be seen only on the right side in the anatomical section, while both foramina, 42, are seen on the tomogram. In the latter, also, we are able to note the lesser wings, 43, of the sphenoid bounding the superior portion of the orbital cavities, 3, which are small, flat, and transverse. In the anatomic section we are behind the orbital cavity and portions of the temporal lobe of the brain are seen. The "H" and "R" lines of the roentgenogram are indistinct and disappearing. The zygomatic arches, 17, are still more prominent on this tomogram than they have been on previous films.

Figure 18 is at the level of the mid-portion of the zygomatic arch and is beyond any bony landmarks of the upper alveolar

ridge. Both ascending rami, 20, are in good focus, and the condyles, 44, of these structures are beginning to take form. The neck, 45, of this structure is well seen. Both maxillary antra are now lost to view, and the inferior border of the zygomatic arch, 17, is in fair detail as it curves to meet the maxilla on each side. The nasal cavity is smaller at this level, and the superior nasal conchae, 46, are faintly visible. (Because of the posterior and inferior angulation of all the conchae at this level, these structures cast roentgenographic shadows which seem to coalesce.) The orbital cavities as such are no longer demonstrable, but the greater wings, 40, of the sphenoid are well depicted, especially on the right, and both superior, 26, and inferior orbital fissures, 35, can be seen. The faint shadow of the roof of the orbit, 13, is still visible. The sphenoid sinus, 37, anomalous ethmoid

cell, 25, on the right, and optic foramina, 42, can still be identified. The "H" and "R" lines are no longer visible.

The last postero-anterior tomogram shown, Figure 19, is at the widest (most lateral) portion of the zygomatic arch in the skull. At this level we are 9.5 cm. from the roentgenographic table top. The neck of the condyloid process, 45, on each side is in sharp focus, and the condyles, 44, are being visualized. The temporomandibular joint, 47, is coming into view on the right side. The zygomatic arch, 17, is well seen, and the lateral border is fairly well focused. The inferior edge of the arch is in clear detail, as is its junction with the maxilla on each side. In the nasal chamber it is now possible to distinguish the inferior, middle, and superior, 46, conchae on the right. The remnants of both sphenoid sinus, 37, and posterior ethmoid cell, 25, on the right are seen, as well as the remnant of the optic foramen, 42, on the right. The greater wing of the sphenoid, 40, is receding from critical focus, as are the orbital fissures, 26 and 35, and lesser wing of the sphenoid.

#### LATERAL TOMOGRAPHY

The lateral tomograms pictured here were secured from the same head as the postero-anterior roentgenograms. The anatomic sections, however, were obtained from a second head after the tomograms had been printed. Because anatomic landmarks are the same in both series, comparison is now made of the corresponding sections and tomographic views. One point of difference is noted in comparison. The anatomic views are of a skull in which there are no upper teeth, while in the tomographically sectioned skull most of the upper teeth are present. The bony landmarks selected as planes of lateral sectioning are the zygomatic arch, mastoid process, and the mandible. Although the latter is not a fixed structure, its deviation laterally is an uncommon occurrence, and it is felt that anatomic variations in width of the mandibular arch are of such slight proportions that the levels selected in our series are ap-

plicable to the great majority of individuals.

Figure 20 is the first lateral tomogram in this series, and Figure 21 is the anatomic section to which it most closely corresponds. These sections are at the level of the tubercle of the root of the zygomatic process of the temporal bone, 54. The shadow of the condyle of the mandible, 44, is quite visible in the tomogram and a portion of the condyle is apparent in the anatomic view. The latter delineates the external auditory canal, 63, well, but this structure is not well demonstrated on the tomogram. The angle of the mandible, 48, is well seen on the roentgenographic film. The most lateral portion of the mastoid process, 49, of the temporal bone is also shown. The anatomic level bisects the squamous portion of the temporal bone, 50, and the parietal bone, 51, as well. The roentgenogram does not disclose these structures so clearly, but they can be identified. The zygoma, 52, is seen in both views, and in the roentgenogram it is possible to distinguish the underlying maxilla, 53, and maxillary sinus, 2, which appear in more critical view in deeper films. The frontal process of the zygoma, 14, is seen in this film, and its curvature to form the lateral wall of the orbit, 3, is also visualized. The marginal tubercle of the zygoma, 54, can be identified. Other structures are faintly but not clearly seen.

Figure 22, the next tomogram, is at the level of the tip of the mastoid process. The angle of the mandible, 48, and condyle, 44, are more pronounced, and the coronoid process, 32, is faintly seen. The mastoid process, 49, and its air cells are in clear detail. The mandibular notch, 55, and the tubercle, 54, at the root of the zygomatic process are shown, but the zygomatic arch, 17, is disappearing. The zygoma, 52, is in good focus and its sutural juncture, 59, with the frontal bone is clearly visualized. The heavy linear shadow cast by the curving anterolateral surface of the zygoma, 58, extending superiorly to join the zygomatic process of the frontal bone, as in the previous tomogram, is seen overlying the maxillary sinus, 2, which is still

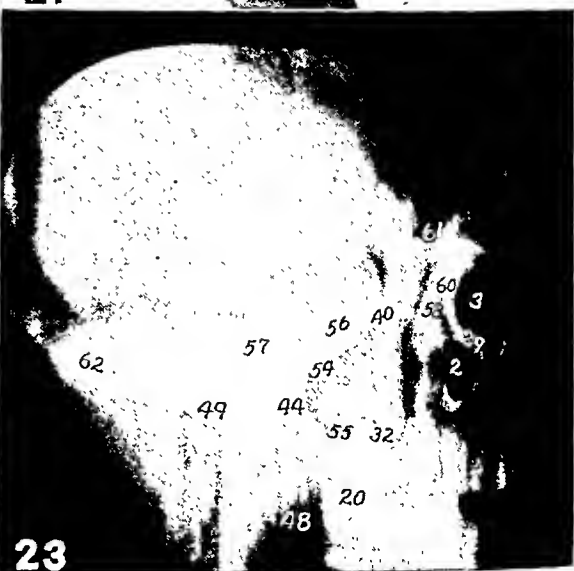
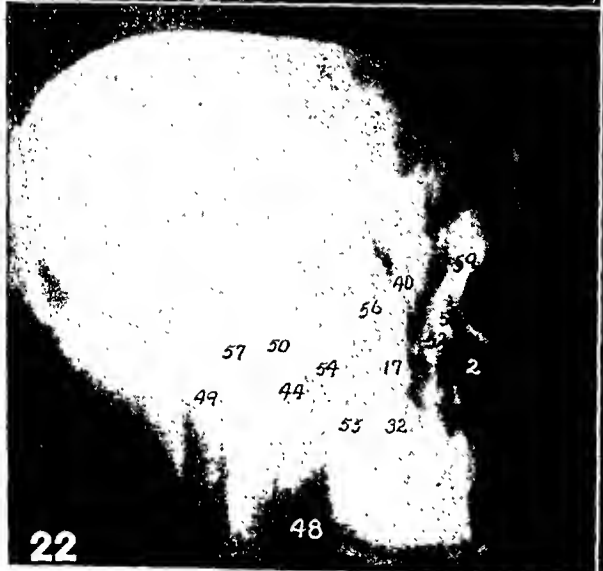
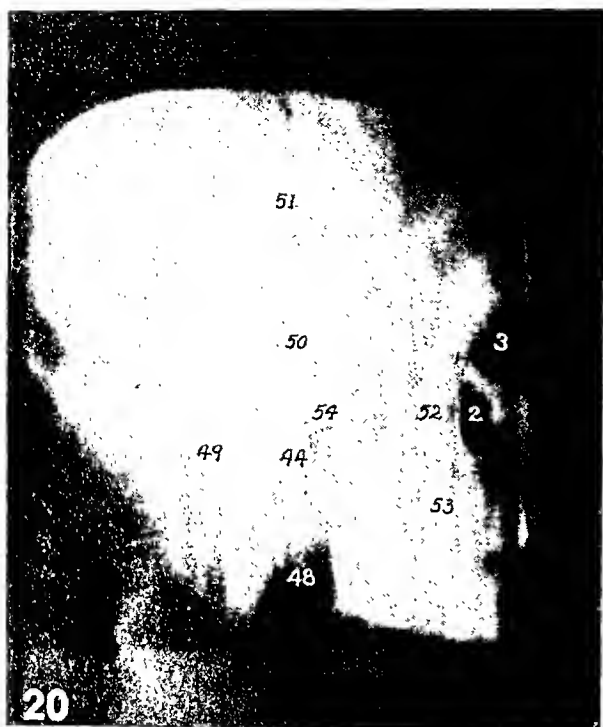


Fig. 20. Sagittal section at the level of the tubercle of the root of the zygomatic process of the temporal bone. 48. Angle of the mandible. 49. Mastoid process. 50. Squamous portion of temporal bone. 51. Parietal bone. 52. Zygoma. 53. Maxilla. 54. Marginal tubercle of zygoma.

Fig. 21. Anatomic sagittal section at level of tubercle of the root of the zygomatic process of the temporal bone. 3. Orbit. 49. Mastoid process of temporal bone. 50. Squamous portion of temporal bone. 51. Parietal bone. 52. Zygoma. 54. Marginal tubercle of zygoma. 63. Auditory canal.

Fig. 22. Sagittal section at level of tip of mastoid process. 55. Mandibular notch. 56. Floor of middle cranial fossa. 57. Petrous portion of temporal bone. 58. Linear shadow cast by curving surface of zygoma. 59. Zygomatico-frontal suture line.

Fig. 23. Sagittal section at level of the coronoid process of the mandible. 60. Posterolateral orbital wall. 61. Anterior cranial fossa. 62. Posterior cranial fossa.

not in good view. The lateral orbital wall is clearer and larger than in the previous film. The floor of the middle cranial fossa, 56, formed at this level by the greater wing

of the sphenoid, 40, and the squamous, 50, and petrous portions, 57, of the temporal bone is just becoming visible.

In Figure 23 we are at the coronoid

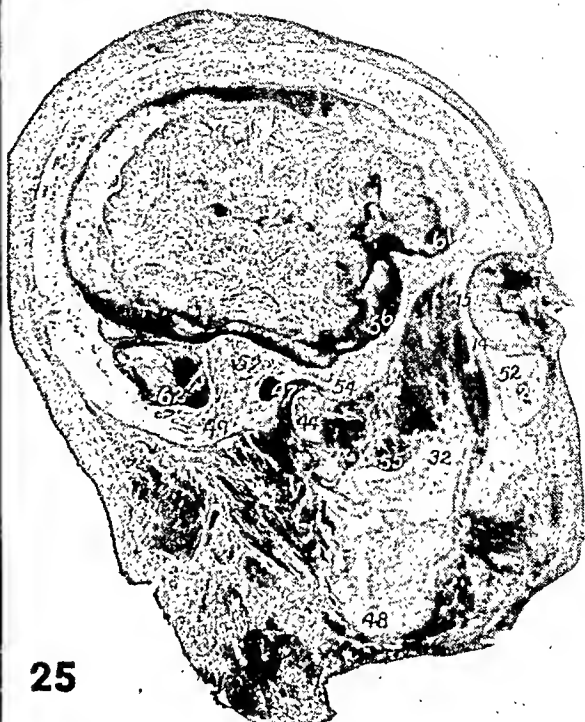
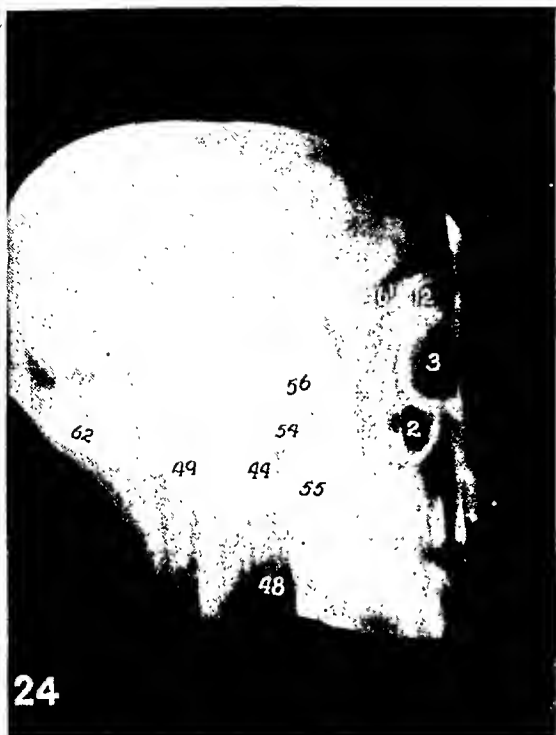


Fig. 24. Sagittal section at level of the condyloid process of the mandible.

Fig. 25. Anatomic sagittal section at the condyloid process of the mandible. 2. Maxillary sinus. 3. Orbital cavity. 14. Frontal process of zygoma. 44. Condyloid process of mandible. 48. Angle of mandible. 49. Mastoid process. 54. Tubercle at the root of the zygomatic process of the temporal bone. 55. Mandibular notch. 56. Middle cranial fossa. 61. Anterior cranial fossa. 62. Posterior cranial fossa.

process, 32, of the mandible. This process, as well as the ascending ramus, 20, of the mandible and its angle, 48, are in sharp detail. The condyle, 44, is in better focus, as are the mandibular notch, 55, and tubercle, 54, of the zygomatic process. We are now within the cavity of the maxillary antrum, 2, and the linear shadow of the curve of the zygoma, 58, is still seen. The posterolateral wall, 60, of the orbit is clear, and the orbital cavity, 3, is larger. The thin inferior wall, 29, of the orbital cavity can be noted separating the orbit, 3, from the antrum. The mastoid process, 49, is still well defined, as are its air cells, although we are beyond its most dependent portion. The middle cranial fossa, 56, is in good focus, the greater wing of the sphenoid, 40, is coming into clearer view, and the petrous portion, 57, of the temporal bone is becoming more prominent. Faintly visible is the anterior cranial fossa, 61, and posteriorly, the posterior cranial fossa, 62, is in good view.

Figures 24 and 25 are comparable tomographic and anatomical levels at the sagittal plane of the condyloid process, 44, of the mandible. This structure is clearly shown in both. The mandibular notch, 55, is clearly outlined. The tubercle, 54, of the root of the zygomatic process of the temporal bone is also seen. The angle, 48, of the mandible is well defined in both views and the shadows of the teeth are making their appearances in the roentgenogram. Slightly above and behind the condyle, 44, of the mandible, the auditory canal is visible. The mastoid process, 49, can be identified in the tomogram, but it is fading from view. We can also see the faint outline of the styloid process, 41, in the tomogram, but it is not apparent in the anatomic section. The maxillary sinus, 2, is clearer on the tomogram than previously. This plane is at a level deeper than the anatomic section, in which only a small portion of the sinus is shown. The frontal process, 14, of the zygoma and a rather indistinct



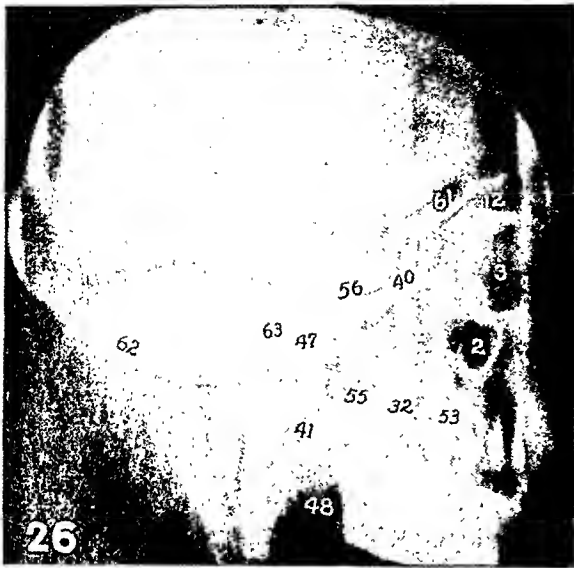


Fig. 26. Sagittal section at the level of the styloid process. 41. Styloid process. 63. Auditory canal.

fusion with the frontal bone are seen. The orbital cavity, 3, is clearly visualized in both views. All the cranial fossae, 61, 56, 62, are recognizable in these views. Between the floor of the anterior cranial fossa, 61, and the superior wall of the orbit there is a wedge-shaped, air-filled cavity. This represents, in this skull, the most lateral projection of the supraorbital sinus, 12. It is more clearly outlined in later films. The anterior walls of this structure are indistinct.

At the next tomographic level, Figure 26, the sagittal plane is at the level of the styloid process, 41. The temporomandibular joint, 47, is still in good focus, and the auditory canal, 63, is well visualized. The presence of an opaque density within its limits suggests that we are at the plane of the ossicles of the middle ear. The coronoid process, 32, is less distinct than in former tomograms. The angle, 48, of the mandible is in good relief, and the shadows of the teeth are becoming clearer. The maxillary antrum, 2, is enlarging, especially posteriorly into the body of the maxilla, 53. The orbital cavity, 3, is fairly well outlined, and the soft-tissue shadows of both eyelids are apparent. All the cranial fossae, 61, 56, 62, are well seen and the greater, 40, and lesser wings, 43, of the sphenoid can be identified. The supra-

orbital sinus, 12, is in sharper relief and the anterior wall is just visible.

Figures 27 and 28 are tomographic and anatomic views, respectively, at approximately the same level, just lateral to the last lower molar tooth. In both, the posterior portion of the ramus, 20, of the mandible is noted, and the tomogram depicts teeth more clearly than earlier films. The ascending ramus and condyle of the mandible, as well as the temporomandibular joint, are lost to view. The internal auditory canal, 63, and petrous portion, 57, of the temporal bone are demonstrated. In both views, also, cerebellar substance, 64, appears in view and the tentorium cerebelli, 65, is visualized. The anatomic section discloses only a small portion of the maxillary antrum, 2, but the tomogram visualizes this structure in its entirety, extending to the posterior limit of the maxillary bone. The inferior wall of this structure describes a W in its course, the central portion of which is carried upward to the superior wall in a septum, 4, dividing the sinus into two almost equal compartments. The thin orbital plate, 66, of the maxilla can be identified. The osseous limits of the orbital cavity, however, are not distinct, due to the curvature of the walls at this level. The soft-tissue shadows of both eyelids are seen. The supraorbital sinus, 12, is in good detail, and the frontal sinus, 11, just anterior to it is coming into focus. The latter is evident only in the tomogram. All the cranial fossae, 61, 56, 62, are well seen. The overlying edge of the lesser wing of the sphenoid, 43, as it projects to form the anterior clinoid process, 67, is clearly shown. The greater wing of the sphenoid, 40, and petrous portion, 57, of the temporal bone, forming the middle cranial fossa, 56, are discernible. In the tomogram it is possible to identify the spine of the sphenoid bone, 68, projecting downward behind the maxilla below the posterior third of the middle cranial fossa. The posterior cranial fossa, 62, at this level is formed by the concave plate of the occiput, 69, and the petrous portion, 57, of the temporal bone is quite distinct.

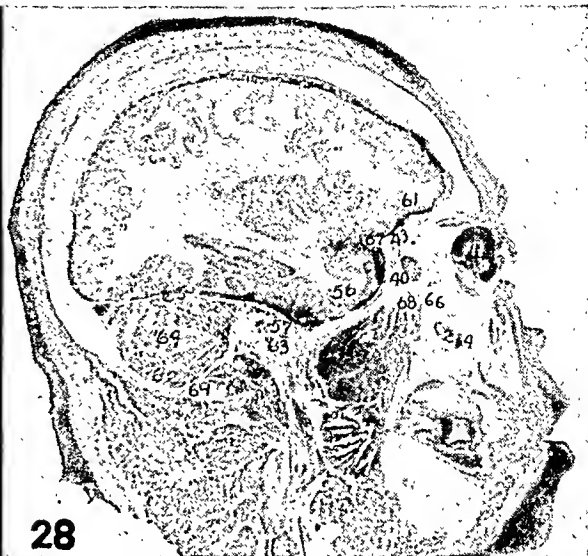
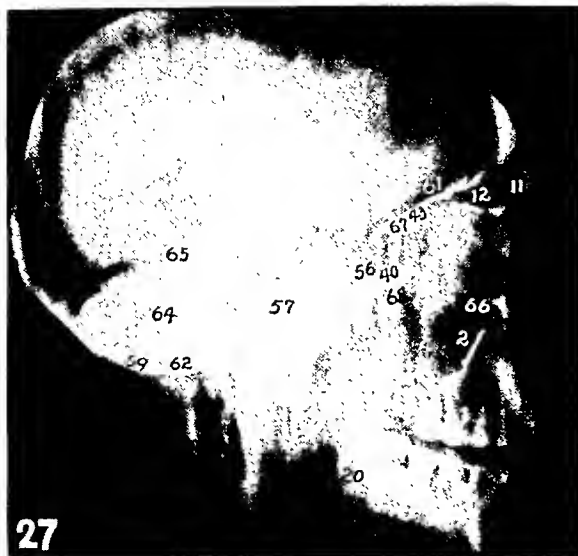


Fig. 27. Sagittal section at a level just lateral to the last molar tooth. 64. Cerebellum. 65. Tentorium cerebelli. 66. Orbital plate of the maxilla. 67. Anterior clinoid process. 68. Spine of the sphenoid bone. 69. Occiput.

Fig. 28. Anatomic sagittal section at a level just lateral to the last molar tooth. 2. Maxillary sinus. 4. Intramaxillary septum. 40. Greater wing of sphenoid bone. 43. Lesser wing of sphenoid bone. 56. Middle cranial fossa. 57. Petrous portion of temporal bone. 61. Anterior cranial fossa. 62. Posterior cranial fossa. 63. Auditory canal. 64. Cerebellum. 65. Tentorium cerebelli. 66. Orbital plate of maxilla. 67. Anterior clinoid process. 68. Spine of sphenoid bone. 69. Occiput (concave plate forming posterior cranial fossa).

In Figure 29 we have entered a tomographic level within the limits of the lower alveolar ridge at the sagittal plane of the second molar tooth. Lower alveolar ridge substance is also fairly well delineated at this level. The upper alveolar ridge is not so distinct. The maxillary sinus, 2, is clear and its osseous limits are in good focus. The orbital cavity, as in the last tomogram, is not well defined. The faint shadows of the posterior ethmoid air cells, 25, are appearing. The supraorbital sinus, 12, is clearer and its posterior extent toward the anterior clinoid process, 67, is visualized. The frontal sinus, 11, is better seen than previously, although not in sharp detail. All the cranial fossae, 61, 56, 62, are well shown. Below the mid-portion of the middle cranial fossa, the faint shadow of the lateral pterygoid plate, 70, can be seen. (Its anterior border is easily confused with the posterior wall of the maxillary antrum, but these two structures are distinct and separate.) The internal auditory canal, 63, is also demonstrated. As in previous tomograms, we are able to distinguish the lateral cerebral ventricle. Just as in the

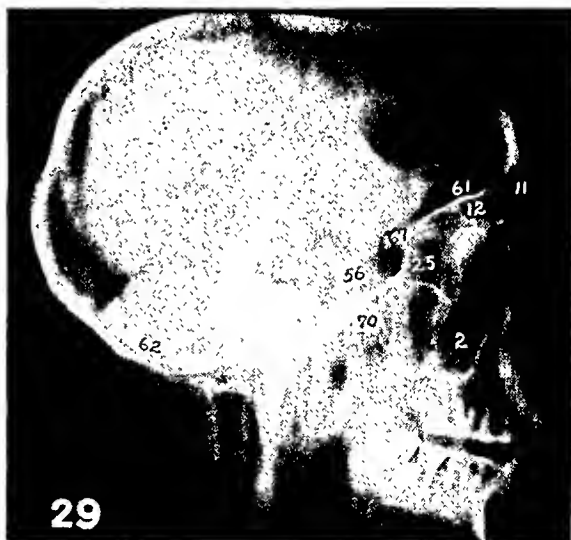


Fig. 29. Sagittal section at the level of the lower second molar tooth. 70. Lateral pterygoid plate.

postero-anterior tomograms, the ventricles are visible in this particular skull. As mentioned previously, this is due to the fact that the skull was exposed to air for some time and the fluid substance has been, for the most part, lost. In ordinary tomography we are not able to distinguish these structures clearly.



Figures 30 and 31 are comparable tomographic and anatomic sections at the sagittal plane of the second lower bicuspid tooth. Bone substance in this area is well seen. The premaxilla, 71, is in fairly good focus, as are the two upper molar and bicuspid teeth. The maxillary antrum, 2, is not quite so clear as in the previous tomogram, but the anatomic section shows this structure exceedingly well. In the tomogram the lateral pterygoid plate, 70, is very well seen, as is also the pterygo-maxillary fissure, 72. Its junction with the body of the sphenoid bone, 73, which is beginning to appear in focus, is shown. The sphenoid sinus, 37, is just making its appearance in the tomogram. Above the posterior half of the maxillary antrum in both views we can visualize several posterior, 25, and middle ethmoidal, 8, air cells. Anterior to this area, the orbital cavity, 3, is small and in the tomogram rather indistinct. Supraorbital, 12, and frontal, 11, sinuses are well depicted in the roentgenographic view, while only the former is shown in the anatomic section. The anterior clinoid process, 67, is still visualized, and all the cranial fossae, 61, 56, 62, are well seen. The channel of the internal auditory canal, 63, is visualized in the anatomic view. Although radiographic visualization of the cervical spine is evident, these anatomic relations are not pertinent to the subject under discussion, and identification of these structures is therefore omitted.

Figures 32 and 33 are approximately corresponding tomographic and anatomic levels at the sagittal plane of the level of the first lower bicuspid tooth. The anterior portion of the mandibular ramus, is well seen in both views. The maxillary antrum, 2, at this level is much smaller and elongated anteroposteriorly in the anatomic view. In the tomogram, because of the inclusion of a certain amount of tissue in the focal field, we are able to delineate the entire width and length of the sinus, but as in the last tomogram, it is not so clear as previously and is receding from the tomographic field. The pterygo-

maxillary fissure, 72, is well outlined in the tomogram and is also visible in the anatomic view, the medial plate of the pterygoid process, 74, also being delineated. The horizontal plate of the palatine bone, 75, is also in view, and in the tomogram the indistinct shadow of the soft palate, 76, is making its appearance. The premaxilla, 71, is seen in both sagittal views. The orbital cavity at this level is very small and is not well outlined. In the tomogram, the body of the sphenoid bone, 73, is shown and the sphenoid sinus, 37, is visualized. Because we are lateral to the mid-line of the skull, the sinus appears to encroach upon the sella turcica, 77, which is making its appearance, but this is due to superimposition of images. In the anatomic view, only a small portion of the sphenoid air cell is visible, and the sella is not so well formed. In both views posterior, 25, middle, 8, and a few anterior ethmoid air cells are delineated. The supraorbital sinus, 12, is smaller in both views and the frontal sinus, 11, is quite well demonstrated. In the anatomic view we are beyond the petrous portion of the temporal bone and note the junction of the basi-occiput, 81, and the sphenoid bone. Receding from distinct view, but still apparent in the tomogram, is the petrous portion of the temporal bone, 57, as well as the internal auditory canal, 63. The dorsum sellae, 78, is fairly outlined. The rather thin inferior wall of the occiput, 69, is quite well seen in both views. Tongue, 28, substance is evident.

At the next tomographic and anatomic level, shown in Figures 34 and 35, we are at the sagittal level of the lower lateral incisor teeth. The premaxilla, 71, and palatine process of the maxillary bone, 79, are quite clear, and the horizontal plate of the palatine bone, 75, is also distinct. A portion of the perpendicular plate, 80, of the latter is seen in the anatomic section, while the tomogram shows this portion of the palatine bone rather indistinctly. The maxillary sinus has disappeared from view, and in the tomogram we begin to observe the forms of both inferior, 7, and middle

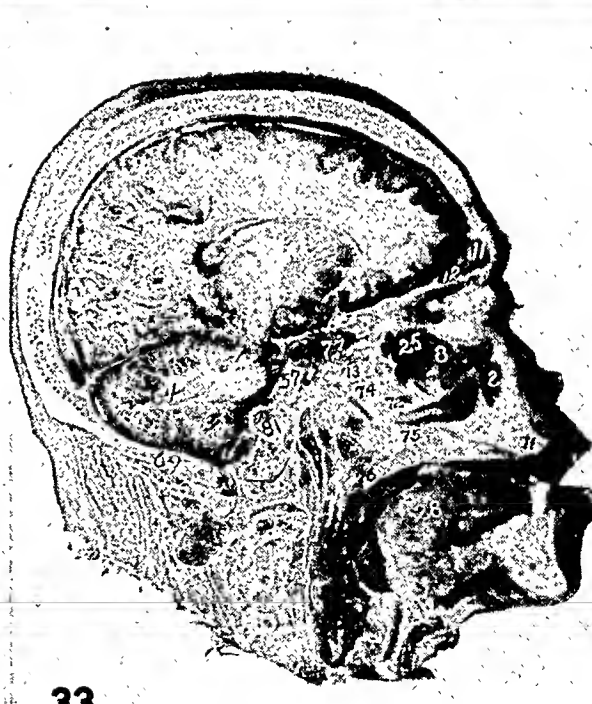
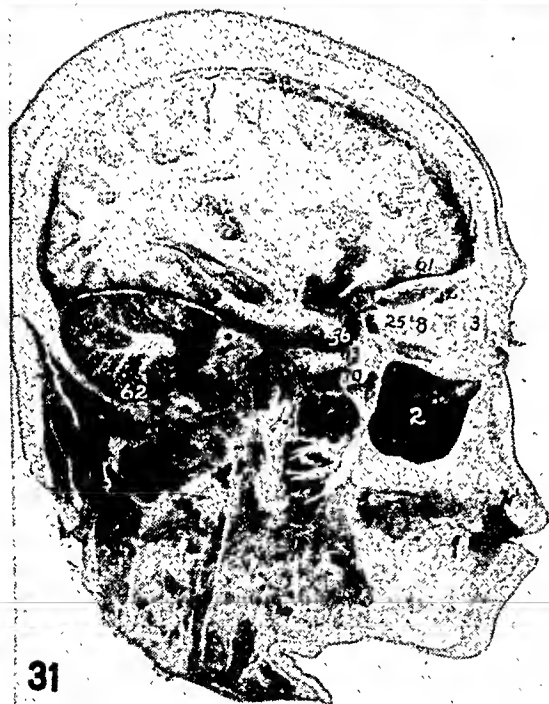
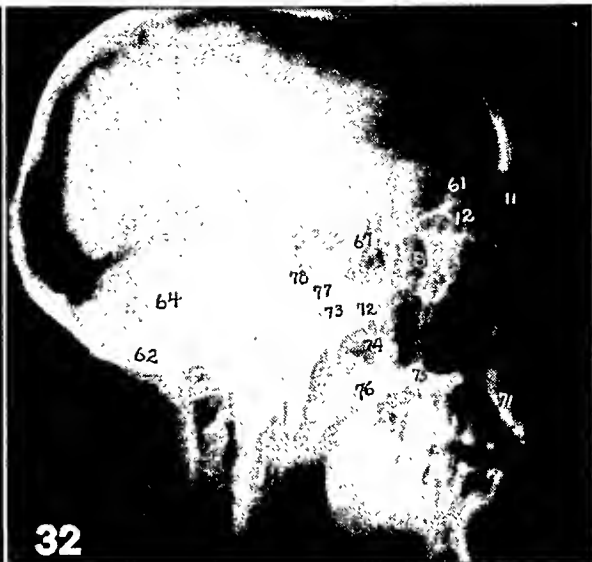
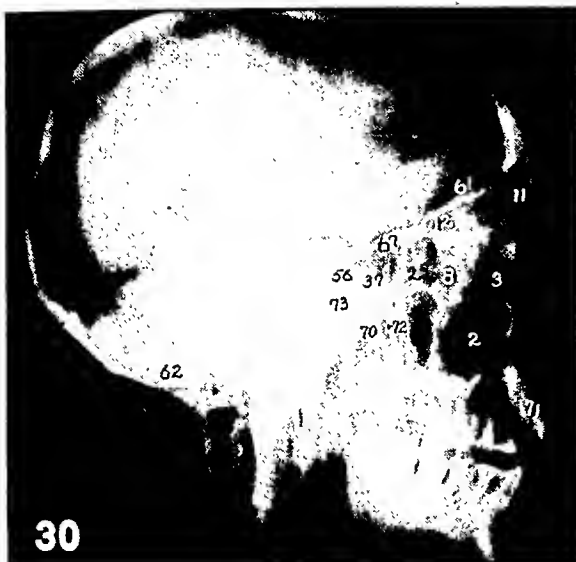


Fig. 30. Sagittal section at the level of the second lower bicuspid tooth. 71. Premaxilla. 72. Pterygo-maxillary fissure. 73. Body of sphenoid bone.

Fig. 31. Anatomic sagittal section at the level of the second lower bicuspid tooth. 2. Maxillary sinus. 3. Orbital cavity. 12. Supraorbital sinus. 56. Middle cranial fossa. 61. Anterior cranial fossa. 62. Posterior cranial fossa. 63. Auditory canal. 67. Anterior clinoid process. 71. Premaxilla. 73. Body of sphenoid bone.

Fig. 32. Sagittal section at the level of the first lower bicuspid tooth. 74. Medial pterygoid plate. 75. Horizontal plate of palatine bone. 76. Soft palate. 77. Sella turcica. 78. Dorsum sellae.

Fig. 33. Anatomic sagittal section at level of the first lower bicuspid tooth. 2. Maxillary sinus. 8. Middle ethmoidal air cells. 11. Frontal sinus. 12. Supraorbital sinus. 25. Posterior ethmoidal air cells. 28. Tongue. 57. Petrous portion of temporal bone. 64. Cerebellum. 69. Occiput. 71. Premaxilla. 72. Pterygo-maxillary fissure. 73. Body of sphenoid bone. 74. Medial pterygoid plate. 75. Horizontal plate of palatine bone. 76. Soft palate. 77. Sella turcica.

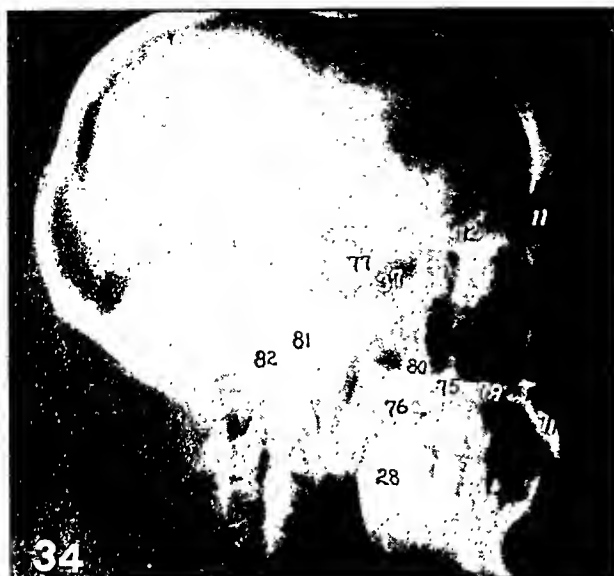


Fig. 34. Sagittal section at level of lower lateral incisor teeth. 79. Palatine process of maxillary bone. 80. Perpendicular plate of palatine bone. 81. Basi-occiput. 82. Foramen magnum.

Fig. 35. Anatomic sagittal section at level of lower lateral incisor teeth. 7. Inferior concha. 8. Anterior and middle ethmoidal air cells. 11. Frontal sinus. 12. Supraorbital sinus. 16. Middle concha. 25. Posterior ethmoidal air cells. 28. Tongue. 37. Sphenoid sinus. 71. Premaxilla. 75. Horizontal plate of palatine bone. 76. Soft palate. 77. Sella turcica. 79. Palatine process of maxillary bone. 80. Perpendicular plate of palatine bone. 82. Foramen magnum.

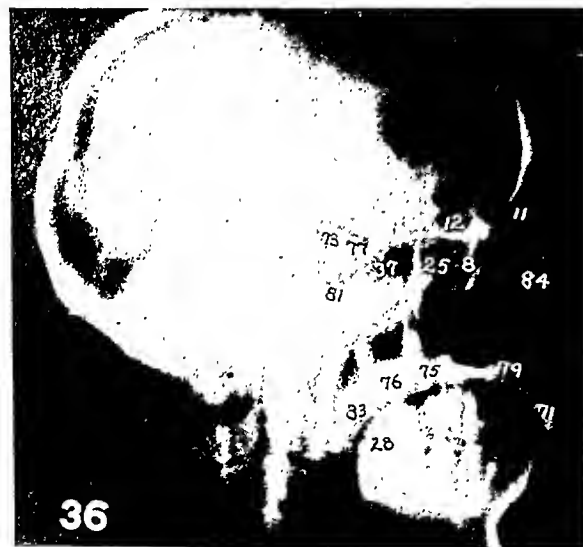


Fig. 36. Sagittal section at the level of the lower central incisor teeth. 83. Uvula. 84. Nasal bone.

conchae, 16. In the anatomic view we are just able to distinguish a portion of the inferior concha, 7, within the nasal chamber. The orbital cavity has almost completely disappeared and we can visualize anterior, middle, 8, and posterior ethmoid sinuses, 25. The sphenoid sinus, 37, is now clear in both views, although superimposition upon the sella turcica, 77, still exists in the

tomogram. The supraorbital sinus, 12, is still in view and the frontal sinus, 11, is very clear. In the tomogram what appears to be the ostium of the frontal sinus is seen. The hypophyseal fossa is still not clearly outlined in the anatomic section, but is quite clear in the tomograph. We are beyond the petrous portion of temporal bone in both views, and the basi-occiput, 81, and beginning of the foramen magnum, 82, are shown. The soft-tissue shadows of both the soft palate, 76, and tongue, 28, are clearer than in previous views.

Figure 36 is the tomographic view of the sagittal plane at the level of the lower central incisor. The anterior portion of the mandible is quite clear. The premaxilla, 71, and palatine process of the maxillary bone, 79, are clear, and both horizontal, 75, and perpendicular, 80, plates of the palatine are well seen. The soft-tissue shadows of the soft palate, 76, and tongue, 28, are more pronounced and the uvula, 83, is becoming distinct. The outlines of both middle, 16, and inferior, 7, conchae are still visualized but not so clearly as in the last tomographic view. The body of the sphenoid bone, is quite clear, and the sphenoid

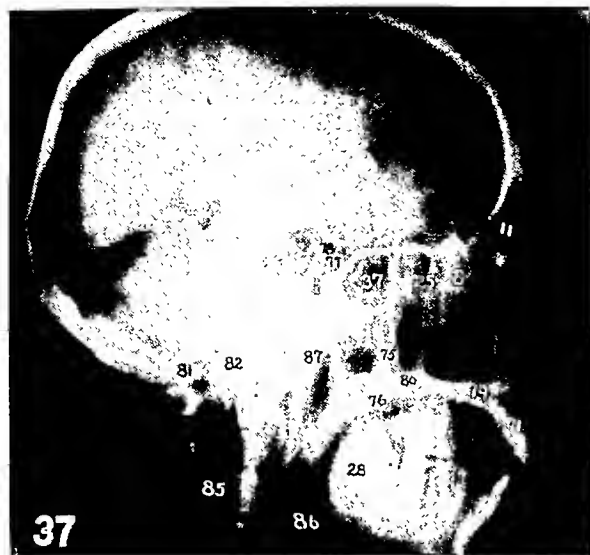


Fig. 37. Sagittal section at level of the mid-line of the skull. 85. Spinal cord. 86. Laryngeal part of pharynx (hypopharynx). 87. Nasopharynx.

Fig. 38. Anatomic sagittal section at the mid-line of the skull. 8. Anterior and middle ethmoidal air cells. 11. Frontal sinus. 25. Posterior ethmoidal air cells. 28. Tongue. 37. Sphenoid sinus. 71. Premaxilla. 75. Horizontal plate of palatine bone. 76. Soft palate. 77. Sella turcica. 78. Dorsum sellae. 79. Palatine process of maxillary bone. 81. Basi-occiput. 82. Foramen magnum. 83. Uvula. 84. Nasal bone. 85. Spinal cord. 86. Laryngeal part of pharynx (hypopharynx). 87. Nasopharynx.

sinus, 37, is excellently outlined. All ethmoidal sinuses from anterior to posterior, 25, are seen, as is the supraorbital air cell, 12. The frontal sinus, 11, is in very clear detail and the nasal bone, 84, is beginning to be seen. The hypophyseal fossa, 77, is in good focus. The foramen magnum, 82, appears larger than in the last roentgenogram.

Our last views, Figures 37 and 38, are at the sagittal plane of the mid-line of the skull and represent the tomographic and anatomic views in that plane. The mandible in this area is delineated in both views, as are the central incisors. Tongue substance, 28, soft palate, 76, and uvula, 83, are also well seen in both. The premaxilla, 71, palatine process of the maxilla, 79, and the horizontal plate of the palatine bone, 75, are in good view. A portion of the perpendicular plate, 80, is shown in the tomogram. The maxillary sinus and orbital cavity are out of the focal field. Anterior, middle, 8, and posterior, 25, ethmoid sinuses are visualized, and the frontal sinus, 11, is seen in excellent detail, especially in the roentgenogram. The supraorbital sinus is not visualized in either view.

The sphenoid sinus, 37, is very well seen, and the hypophyseal fossa, 77, is clear in both views. The dorsum sellae, 78, can be outlined. The basi-occiput, 81, and foramen magnum, 82, are well depicted, and it is possible to distinguish the spinal cord, 85, as it enters the cranial vault in both these views. In both the anatomic section and the tomogram we can follow the posterior pharyngeal walls from the laryngeal part of the pharynx, 86, up to the roof of the nasopharynx, 87, and it is possible to visualize the inferior, 7, middle, 16, and superior, 46, conchae. The orifice of the eustachian tube is visible in the anatomic section, lying just above the posterior portion of the horizontal plate of the palatine bone.

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# Osteitis Deformans: Paget's Disease of the Bone<sup>1</sup>

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**O**STEITIS deformans was described by Sir James Paget (1) in 1876 and now bears his name. Very little has been added to his explicit observations on the advanced clinical form of the disease. Biochemical, pathologic, and roentgenologic investigations have made it possible, however, to segregate osteitis deformans in its preclinical stage from a large group of forms of benign osteitis.

At the Mayo Clinic prior to January 1938, a diagnosis of osteitis deformans was made in 367 cases. The analysis of the findings in that group will be given in this paper. It is not a new observation that osteitis deformans manifests itself roentgenologically in various forms. In this study, however, we shall attempt to correlate the clinical manifestations of the disease with the roentgenologic evidence in a series of 200 cases. The criteria for the roentgenographic classification will be discussed later.

## HISTORICAL REVIEW

Both Wranby, in 1867, and Wilks (2), in 1869, as quoted by Paget, deserve credit for recognizing the clinical form of osteitis deformans. The two cases described by those men were among the five recorded in Paget's original paper. Paget was inclined to believe that the disease was of recent origin, but paleopathologic evidence based on old museum specimens is an indication of its presence long before

modern times. Denninger (3) described gross morphologic and roentgenologic evidence of osteitis deformans in the skeletons of five American Indians, excavated from the Illinois River valley. Fisher (4) reported additional paleopathologic evidence of the condition in two tibiae; the disease is well described and well illustrated in his paper. Following the examination of a number of skulls in the South Kensington Natural History Museum, Butlin (5) expressed the opinion that the Neanderthal skull had the appearance of a specimen representing osteitis deformans.

## ETIOLOGY

As the term osteitis deformans implies, Paget (1) believed the disease to be a chronic inflammatory process. Fairly frequently, local heat may be demonstrated in the involved bones, particularly in those which are easily palpable, as for example the tibia and even occasionally the ilium.

DaCosta *et al.* (6) referred to the work of Morpure, Archangeli and Fiocca, who claimed to have found a diplococcus in the bones of patients suffering from osteitis deformans and osteomalacia. DaCosta and his associates unsuccessfully attempted to prepare a vaccine, but cultures and animal inoculation gave negative results. Knaggs (7 and 8) expressed the belief that a toxin was responsible for osteitis deformans. In his opinion the proliferative changes were more prominent than the

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TABLE I: STUDIES OF THE BLOOD IN 367 CASES OF OSTEITIS DEFORMANS\*

	Patients	Deter- minations	Concentration		
			Minimum	Maximum	Average
Calcium	117	167	8†	11.6†	9.8†
Phosphorus	111	163	1.6†	5.3†	3.48†
Alkaline phosphatase	101	148	1.3‡	216‡	25.53‡

\* The chemical work was performed by the Section on Clinical Biochemistry under the direction of Dr. Osterberg.

† Mg. in each 100 c.c. of serum.

‡ Bodansky units in each 100 c.c. of serum.

vascular disturbances, and evidence of leukocytic migration was minimal. Such changes, when not to be explained on a bacterial basis, may be the result of repeated slight mechanical injuries, or more often the effects of perverted metabolism and continued slight intoxication, affecting particularly certain tissues. According to Knaggs, changes of the medullary tissue of patients whose condition has been diagnosed as osteitis deformans conform to this description and are attributable to irritation by a toxin.

Lancereaux (9), in 1883, suggested that the central nervous system played an important role in the production of osteitis deformans. This hypothesis has gained consideration from time to time, mainly on the ground of the frequent occurrence of skeletal changes, neurotrophic in origin, among patients whose condition has been diagnosed as tabes dorsalis or syringomyelia.

In 1884, Gilles de la Tourette and Marenesco (10) found lesions in the medulla and peripheral nerves associated with osteitis deformans but thought that they were the result of senility. Such associated lesions of the central nervous system are so diverse that it is much more reasonable to regard them as mechanical in origin or the result of arteriosclerosis than as causative factors in the production of osteitis deformans.

Lannelongue (11) and Fournier (12), as well as many other French investigators, have urged the syphilitic origin of osteitis deformans. Kay and her associates (13), in a study of 34 cases with a diagnosis of osteitis deformans, found the Wassermann reaction positive in 3. Gutman and Kasabach (14) reported a positive Wassermann

reaction in 7 of a series of 116 cases. Among our 367 cases, there were only 11 in which a positive Wassermann reaction was obtained. From these observations there is little to suggest syphilis as a causative factor.

DaCosta and his associates considered osteitis deformans a disorder of metabolism of bone dependent on the absence or perversion of some internal secretion. Since the suggestion of this possibility, numerous hypotheses of a similar nature have been put forth. Albright, Aub and Bauer (15), however, held that osteitis deformans is not a form of hyperparathyroidism, as some authors have contended: first, because, though osteitis deformans is often polyostotic, it is never generalized, which is almost inconceivable for a metabolic disease; second, because of failure to demonstrate histologic changes in the parathyroid glands of patients suffering from osteitis deformans; and, third, on account of the lack of similarity of the metabolic changes of the two conditions.

The range of the serum calcium of the blood observed in our cases (Table I) does not give any indication of disturbed calcium metabolism. Furthermore, in osteitis deformans different phases of a similar pathologic process are observed in the same bone. If the parathyroid gland or other glands of internal secretion were at fault, it would be difficult to explain such variability. Instead, one would expect to find a more uniform, generalized process, as demonstrated in the bones in cases of hyperparathyroidism.

Moehlig (16 and 17), having obtained a family history of diabetes mellitus in 5 of 12 patients with osteitis deformans, stresses the former disease from an etiologic stand-



point. In the present study only 6 of the patients had diabetes mellitus as a complicating factor and only 18 gave a family history of diabetes.

#### AGE INCIDENCE

Osteitis deformans usually manifests itself during middle life; it is encountered rarely before the age of thirty years. In one of the cases included in Paget's series the onset occurred at twenty-eight years. One of the patients in our series was a man of twenty-nine at the time the diagnosis was made. Roentgenologic changes typical of this condition were observed in the lumbar segment of the spinal column, sacrum, pelvis, and femora. Osteoporosis circumscripta was observed in the skull. This patient gave a history of pain in the right hip and low back region of four years' duration. Packard, Steele, and Kirkbride (18) found the average age at onset to be forty-nine and a half years in a series of 51 cases; the youngest patient was thirty-nine and the oldest eighty-two years of age. In a series of 34 cases, Kay and her associates (13) found the average age, on examination, to be fifty-five years, the youngest patient being thirty-nine and the oldest seventy-eight. The average age at onset of symptoms was forty-six years; the youngest patient was thirty and the oldest sixty years old.

In our series of 367 cases, the average age at the time diagnosis was made was fifty-six years, while the average age at onset of symptoms was fifty-three. The youngest patient was twenty-nine years of age (Table II) at diagnosis, and the oldest was eighty-three.

#### SEX INCIDENCE

In 1901, Packard, Steele, and Kirkbride (18), in a review of the literature, found osteitis deformans reported as affecting forty-one men and twenty-four women. In Roberts and Cohen's series (19) there were 11 men and 5 women. In a series reported by Gutman and Kasabach (14) there were 58 men and 58 women. Our group consisted of 246 men and 121 women.

TABLE II: OSTEITIS DEFORMANS: AGE AT ONSET AND AGE AT DIAGNOSIS

Age at Onset		Age at Diagnosis	
Years	Cases	Years	Cases
18	1	...	...
20-29	10	29	1
30-39	44	30-39	29
40-49	73	40-49	70
50-59	128	50-59	134
60-69	84	60-69	97
70-79	25	70-79	33
80-89	2	80-89	3
Total	367		367

#### FAMILIAL INCIDENCE

The occurrence of osteitis deformans in more than one member of a family has been recorded fairly frequently. Roberts and Cohen (19) in their review of the literature found 13 cases in which there was a familial background. Two of these cases were their own; in these the patients were sisters. In our group 16 patients had 21 relatives for whom a similar diagnosis had been made. In 2 cases there was a family history of the condition affecting more than one relative. In one of these cases the patient's mother, brother (a physician), maternal grandmother, maternal great grandmother, and one aunt were affected with the same disease. In another case, the patient's sister and one brother had osteitis deformans. In one instance a diagnosis of osteitis deformans involving the tibia was made in each of identical twins.

#### MODE OF ONSET

Osteitis deformans may be present for many years without the patient's cognizance of anything unusual. It is a common occurrence for the condition to be discovered incidentally in the course of roentgenologic examination of the genito-urinary tract, thorax, paranasal sinuses, or gastro-intestinal tract. Gutman and Kasabach's analysis (14) of data on 116 cases revealed the fact that in 27 the patients had not observed any symptoms and there was no indication of the existence of the condition at the time the roentgen diagnosis was made. In our series of 367 cases, 75 patients (20 per cent) had no complaints



and were not aware of anything unusual which could be attributed to the osteitis deformans (Table III).

TABLE III: OSTEITIS DEFORMANS: MAJOR COMPLAINTS IN 367 CASES\*

Complaint	Patients
Backache.....	119
Headache.....	64
Pain in legs.....	58
Pain in hips.....	55
Deafness.....	53
Fatigue.....	49
Pain in knees.....	46
Vertigo.....	37
Pain in thighs.....	29
Tinnitus.....	24
Neuralgia.....	17
Sciatica.....	11
Loss of sense of taste.....	2
Loss of sense of smell.....	2
No complaint.....	75

\* More than one complaint in a number of cases.

#### ROENTGENOLOGIC MANIFESTATIONS

Many investigators have observed the variation of the roentgenologic manifestations of osteitis deformans. Various bones display discernible features dependent on the phase of the disease and upon their own architecture. On the basis of this variation, an attempt has been made to classify the disease into two phases: (1) the sclerotic phase (Fig. 1) and (2) the combined phase (Fig. 2).

For this study we have selected the roentgenograms of 200 of our 367 patients, 100 cases representing each phase. A study has been made correlating the clinical aspect with the roentgenographic manifestation of the disease as it is encountered in the pelvis and long bones. In some cases both phases occurred in the same patient; the type in these instances has been determined by the predominant roentgenologic manifestation. The criteria for this classification of the changes encountered in the pelvis and long bones will be discussed individually.

*Pelvis:* In our group of 367 cases the pelvis was the most frequent site of osteitis deformans (Table IV). Schmorl's analysis (20), from an anatomic standpoint, of a great number of cases revealed the disease most frequently in the spinal column, including the sacrum.

In the pelvis, the sclerotic phase is characterized roentgenographically by a homogeneous increase of density of bone, with detail of the cancellous trabeculae no longer perceptible. This form of the disease may involve one or both sides of the pelvis, or it may be confined to any portion of the innominate bones. The ilium is the most frequent site of this sclerotic phase.

TABLE IV: LOCATION OF OSTEITIS DEFORMANS IN 367 CASES\*

Site of Involvement	Cases†	Combined Phase‡ (100 Cases)	Sclerotic Phase‡ (100 Cases)
Pelvis	243		
Iliac bones	...	107	100
Ischii	...	97	73
Pubic bones	...	96	73
Femur	171	68	40
Skull	153	...	...
Tibia	127	51	22
Sacrum	...	42	35
Lumbar spine	103	38	30
Dorsal spine	51	16	9
Clavicle	33	8	15
Humerus	20	9	1
Ribs	12	2	...
Scapula	7	1	...
Radius	7	1	...
Cervical spine	6	2	...
Fibula	6	2	...
Ulna	5	1	...
Os calcis	4	1	2
Patella	4	2	...
Talus	1	...	1

\* Not including bones of the face and base of skull. More than one site of involvement in a number of cases.

† Cases of involvement of given site among total 367 cases.

‡ Classified roentgenographically. In these columns bilateral involvement is counted twice.

The second form of the disease observed in the pelvis has a more complex roentgenographic picture. It has been termed the combined phase, as it represents non-homogeneous alterations of density of bone. Roentgenographically, areas of osteoporosis, osteosclerosis, and cysts are demonstrable. In the osteoporotic regions the cancellous trabeculae may be much coarser than normal and distorted in contour. The sclerotic areas are very similar to those already described; they are confined mainly, however, to the brim and that portion of the pelvis subjected to stress. From an anatomical standpoint,



Fig. 1 (above). Homogeneous increase of density of bone with loss of detail of the cancellous trabeculae, which represents the sclerotic phase of osteitis deformans.

Fig. 2 (below). Areas of osteoporosis, osteosclerosis, and cysts, which represent the combined phase of osteitis deformans.



Fig. 3. Zones of osteoporosis (halisteresis) in the upper and lower ends of both tibiae. These zones represent an early phase of osteitis deformans.

the cyst-like lesions encountered in the roentgenogram represent marrow spaces filled with fat and surrounded by dense trabeculae. They will be discussed more thoroughly later in the course of this paper (page 460).

Sutherland (21) has emphasized the increase of dimensions of the pelvic bones of patients with osteitis deformans as an important point in its differentiation from metastatic cancer, particularly metastases originating from the prostate gland. Osteoplastic carcinomatous metastasis does not produce the deformity of the pelvis often seen in osteitis deformans. Brailsford (22 and 23) has pointed out isolated areas of destruction of the peripheral bony outline in cases of metastasis and has recognized that in such cases the increased

density results, not from coarsened and fused trabeculae, but from deposition of calcium within the cancellous mesh.

*Femur:* The second most common site of osteitis deformans in our series of cases, was the femur (Table IV). The high incidence here may be partially accounted for by the frequency with which the upper ends of the femurs were observed in the roentgenograms of the pelvis. The two forms of the disease already described as occurring in the pelvis are observed also in the femur. However, certain variations from the appearance in the pelvis are encountered because of the shape of the long tubular bones. The characteristic deformities observed in the femur are coxa vara and anterolateral bowing of the shaft.

*Tibia:* As has been stated, there are two forms of osteitis deformans involving the tibia. The earliest roentgenographic evidence of the disease is acute halisteresis, which is most readily demonstrable here. An example is shown in Figure 3. Extension of the disease process, particularly in the tibia, is sharply demarcated from normal bone by a V-shaped region of osteoporosis. The diseased portion of bone has a greater circumference than the adjacent uninvolved portions.

Brailsford (23) expressed the opinion, from a roentgenologic standpoint, that the disease may spread by one of two ways, *via* the periosteum or the endosteum. When the spread occurred by the latter route, the changes were found to be slower than when it occurred by way of the periosteum, and the margins were diffuse. On the other hand, when the spread occurred *via* the periosteum, the latter was gradually elevated from the surface of the bone as a result of a massive growth of subperiosteal osteoid tissue. The tibia occasionally becomes much hypertrophied and a considerable degree of anterior bowing may occur.

*Spinal Column:* An alteration in the density of bone of some anatomic unit of the vertebral column is the earliest demonstrable roentgenographic manifestation of osteitis deformans of the spine; it

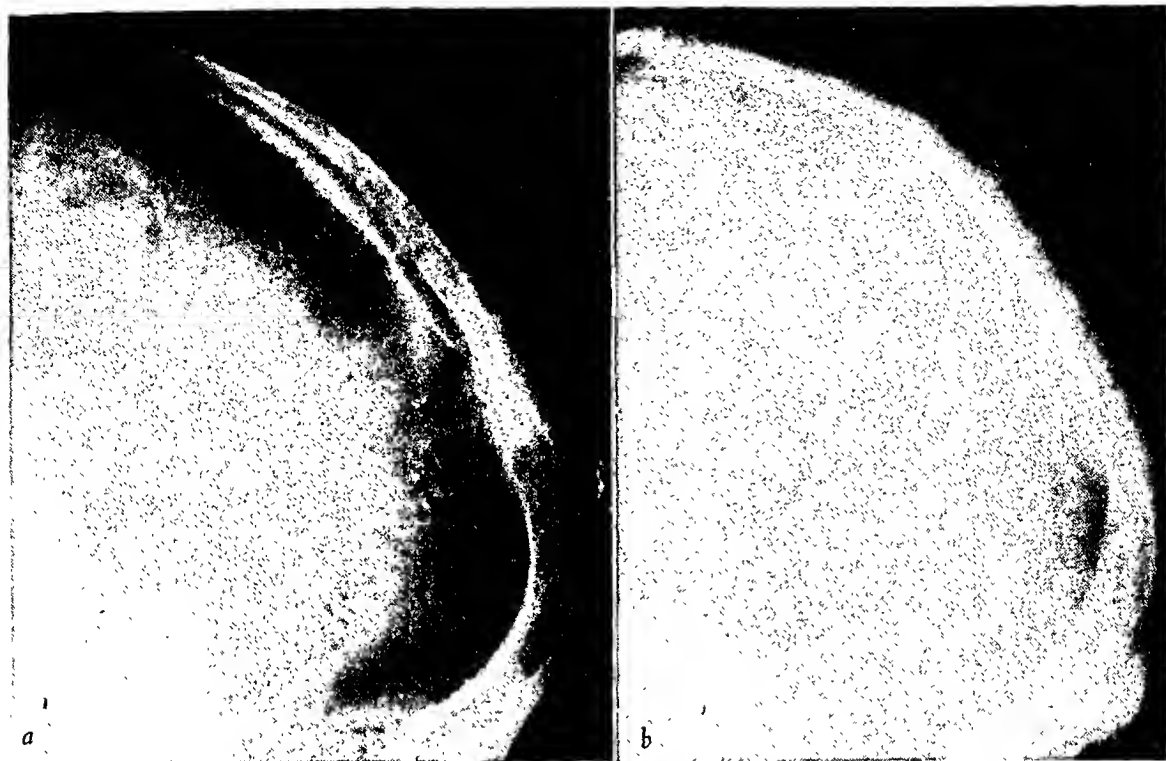


Fig. 4. Lateral views of the parieto-occipital region. *a.* Normal skull. *b.* Diffuse mottled osteoporosis, an early manifestation of osteitis deformans.

occurs most frequently in the body of the vertebra. The most obvious roentgenographic sign of involvement is an increase of the density of the bone as a result of thickening of the trabeculae. These changes occasionally simulate those seen in hemangioma of the vertebra. An increase of the dimensions of the body of the vertebra is frequently encountered.

*Skull:* Osteitis deformans in the skull is usually associated with characteristic changes elsewhere in the skeleton. Recognition of the various early roentgenographic manifestations of the disease in the skull is difficult, particularly when changes are not demonstrable in other bones. It is the opinion of one of us (Camp) that localized or diffuse areas of finely mottled osteoporosis of the skull are an early roentgenographic sign of the disease (Fig. 4). This mottled region of osteoporosis may be associated with zones of diffuse osteoporosis or minute opacities, varying in size from 2 mm. to 1 cm. or more in diameter. In some instances mottled



Fig. 5. Lateral view of skull; circumscribed region of osteoporosis in the posterior portion.

osteoporosis may be the only roentgen evidence of the disease in the skull.

Kasabach and Gutman (24), following a study of their own cases and a review of the literature, concluded that osteoporosis circumscripta of the skull, although a

related process, is relatively independent of osteitis deformans (Fig. 5). In our study of the roentgenograms of 117 patients whose skulls were involved by osteitis deformans, we found 26 cases in which osteoporosis circumscripta was present. In 21 of these cases the osteoporosis was associated with osteitis deformans elsewhere in the skeleton. In some instances subsequent roentgenographic examination demonstrated multiple shadows of increased density of bone, typical of osteitis deformans, appearing in the sharply defined areas of osteoporosis (Fig. 6).

The later roentgenographic changes in the skull consist in multiple shadows of increased density with woolly margins, scattered throughout a thickened calvarium. Usually these changes are associated with areas of diminished density, particularly in the temporal and occipital regions. The outlines of the diploe, vascular markings, and suture lines ultimately become obliterated. The contour of the inner table remains distinct, while identification of that of the external table becomes difficult. Exaggeration of these processes may continue until, in some instances, the thickness of the skull is 1 1/2 inches (4 cm.) or more. Under such circumstances, softening of the base of the skull may result in basioccipital protrusion into the cranium. This condition was observed in 6 of our cases (Table V).

TABLE V: INCIDENCE OF PATHOLOGIC FRACTURE IN 367 CASES OF OSTEITIS DEFORMANS

Location of Fracture	Patients
Thoracic portion of spinal column.....	24
Lumbar portion of spinal column.....	24
Right femur.....	8
Left femur.....	1
Right tibia.....	6
Left tibia.....	3
Right humerus.....	1
Left humerus.....	1
Separation of tibial tubercle.....	2
Ischium (only ununited fracture observed)...	1
Basioccipital protrusion (extensive).....	6
Total number pathologic fractures among 62 patients.....	77

Our study does not include cases in which osteitis deformans has been encountered in the bones of the face. In an interesting and enlightening study by

Stafne and Austin (25), it was found that dental roentgenograms revealed early evidence of the disease. It was present in the maxilla or mandible in 23 cases of a series of 138 in which osteitis deformans had involved one or more bones of the skeleton. The maxilla was involved in 20 of these 23 cases and the mandible in 3. A detailed report of one case was given, in which it was felt possible that the disease was primarily evident in the maxilla.

*Upper Extremity:* Osteitis deformans occurs much less frequently in the upper extremity than in the lower extremity (Table IV). The roentgenographic appearance is similar to that in the other long bones.

*Thorax:* Demonstration of osteitis deformans in the clavicle is fairly common, and in some instances is possible during the early stage of the disease, while involvement of the ribs, sternum, and scapula does not occur, as a rule, until the process has become widespread.

*Bones of the Foot:* In our series we found involvement of the bones of the foot in 5 instances (Table IV). The examination of the diseased bones revealed dense, coarse trabeculae, of considerably increased dimensions.

SYMPTOMS

Twenty-seven of Gutman and Kasabach's 116 patients (14) were asymptomatic at the time the diagnosis of osteitis deformans was made. Seventy-five (20 per cent) of the patients in our series were unaware of any unusual condition so far as the osteitis deformans was concerned (Table III). We examined the roentgenograms of 48 of these 75 patients and classified them, as we have described previously. In 29 the lesions were found to be of the sclerotic type, while 19 were of the combined type.

There is great variation in the pain of osteitis deformans. It is described most frequently as "rheumatic-like." Backache and pain in the lower extremity are encountered frequently (Table III). The pain may be shooting, knife-like, or dull

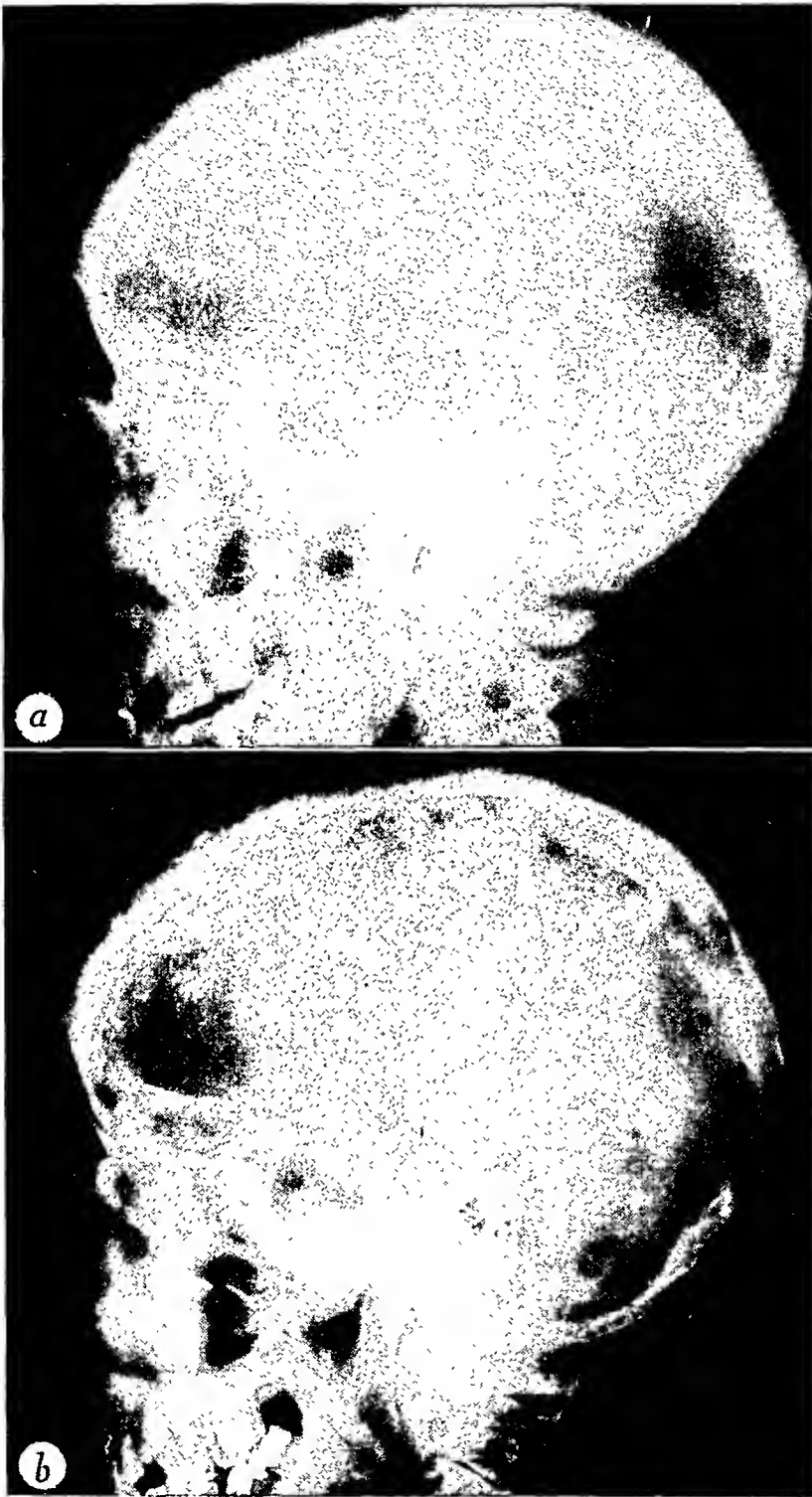


Fig. 6. Lateral views of skull showing osteoporosis. *a*. Extension and sharply defined regions of osteoporosis with thickening and opacities, particularly in the frontal region (osteoporosis circumscripta). *b*. View of same skull taken four and two-thirds years later, showing extension of the osteoporotic zone and typical osteitis deformans.

and aching. There are varying degrees of stiffness of joints, but in some instances the stiffness can be explained on an osteoarthritic basis. In some cases there is a cramp-like pain in the calf muscles. This probably results from ischemia, on an arteriosclerotic basis. Excruciating neuralgic pain of the head and face (Table III) caused considerable distress. Headache, a common complaint, occurred in all portions of the skull and varied considerably in character. In some of the cases, it could be explained on the basis of associated arteriosclerosis and hypertension.

Deafness was given consideration only in those cases in which there was involvement of the skull. Following a study of their cases and a review of the literature, Lindsay and Perlman (26) concluded that impairment of the inner ear is a characteristic finding in those cases of osteitis deformans in which deafness is a complicating factor.

Fatigue was a major feature in 49 of the cases in our series, and in some instances physical exhaustion could be brought on with only minimal exertion. Fatigue was particularly common in those cases in which there was extensive deformity.

#### LESIONS OF THE NERVOUS SYSTEM

*Compression of the Spinal Cord:* The report by Kay and her associates (13) of 34 cases included 2 in which there was spastic paraplegia as a result of compression of the spinal cord. In our series there was neurologic evidence of compression of the cord following pathologic fracture of the vertebrae in 6 cases. Laminectomy had been performed four times on one patient in a period of five years. The operations had been carried out for relief of compression following numerous pathologic fractures of the vertebral bodies. Ultimately, in order to obtain relief from pain, the patient submitted to a fifth operative procedure, which consisted of chordotomy.

*Psychosis:* In our series, there were 4 cases in which a psychosis was encountered. One of the patients was a woman, aged

sixty-two years, who had had delusions with ideas of reference. Another was a man, aged thirty-seven years, who was in a marked paranoid state at the time of his admission to the clinic, while a third was a woman, aged fifty-nine years, who suffered from poor memory, disorientation, and apathy. Marked disorientation was observed in the fourth patient, a man of fifty-eight years.

Mental deterioration of a less severe degree was encountered more frequently, particularly poor memory for recent events. Two of the patients had aphasia and one of these suffered from apraxia.

From the foregoing observations, the mental status of the patients included in this series of cases would appear equivalent to the mental status of people in a similar age group without osteitis deformans.

#### BIOCHEMICAL ALTERATIONS

*Alteration of Chemical Composition of the Blood:* Hunter (27) stated that "in Paget's disease the serum calcium and plasma phosphorus are practically normal." Kay and her associates (13) concluded, following an analysis of their cases, that the average concentration of calcium was slightly less than normal, namely, 9.1 mg. per 100 c.c. of serum (normal 9 to 10.5 mg. per 100 c.c. of serum). They found the concentration of phosphorus to average 3.7 mg. per 100 c.c. of plasma (normal 3.3 mg. per 100 c.c. of plasma), which they considered to be a slight elevation. For the concentrations of calcium and phosphorus in our series see Table I.

The most striking alteration in the blood of patients with osteitis deformans is an elevation of the concentration of phosphatase, which was first brought to the attention of the medical profession by Kay (28) in 1929. At that time she brought out the fact that the plasma phosphatase was elevated occasionally to as high as twenty times the normal evaluation. She also emphasized that this enzyme was present in relatively large amounts in cases of generalized diseases of bone (29),



namely, osteitis fibrosa, osteomalacia, renal rickets, adolescent rickets, and infantile rickets. The increase in plasma phosphatase in patients with osteitis deformans was corroborated by Roberts (30) in 1930, while, according to Gutman and others (31-34), there is an increase of the phosphatase activity of the blood in multiple myeloma, metastatic carcinoma of bone, particularly the osteoplastic type, and carcinomatous metastasis to the liver with or without jaundice.

The activity of alkaline phosphatase in the serum was determined in 101 of the cases in our series, in accordance with the method employed by Bodansky (35) and described by him in 1933. The alkaline phosphatase level ranged from 1.3 to 216 Bodansky units (Table I). Higher levels for the serum alkaline phosphatase were found in those cases which were classified roentgenographically as the combined phase than in the sclerotic phase (Table VI). It is logical to assume, from this, that the sclerotic form of the disease is a less active phase than the combined form or that it is an evidence of healing. As has been pointed out previously by Kay (28), Gutman and others (33), and by O'Reilly and Race (36 and 37), a rough proportionality exists between the extent of the disease and the activity of phosphatase.

The determination of the activity of phosphatase is of little value in making a diagnosis in early localized forms of the disease, as the elevation in such cases may be slight or absent. In more advanced cases the roentgenographic evidence of the disease is usually obvious.

*Changes of Mineral Metabolism:* In osteitis deformans, the skeletal structure is altered considerably, and it is only logical to assume that there will be severe disturbance of the mineral metabolism. Studies of this feature of the disease have been carried out from time to time, the first being made in 1904 by Goldthwait, Painter, and Osgood (38), who reported calcium retention of 6 per cent by a patient who had been observed for seven and a third days. In 1915, DaCosta *et al.* (6)

TABLE VI: ACTIVITY OF ALKALINE PHOSPHATASE IN THE SERUM IN 57 CASES OF OSTEITIS DEFORMANS\*

Bodansky Units per 100 c.c. of Serum	Cases	
	Combined Type†	Sclerotic Type†
0-4	2	5
5-9	7	9
10-24	9	8
25-49	9	4
50-74	1	0
75-99	1	0
100 or more	2	0
Total	31	26

\* The chemical work was performed by the Section on Clinical Biochemistry under the direction of Dr. Osterberg.

† The activity of alkaline phosphatase in the serum in cases of the sclerotic type does not exceed 50 Bodansky units per 100 c.c. of serum.

made a complete metabolic study of 2 cases of osteitis deformans. In one of these the disease had reached an advanced stage, while in the other it was in the early stage. In the first case there was pronounced retention of calcium, magnesium, and phosphorus with considerable loss of sulfur. In the other there was less marked retention of calcium, magnesium, and phosphorus with no loss of sulfur. In each instance the amount of calcium excreted in the urine was much lower than normal.

*Changes of Chemical Composition of Bone:* Various bones from four patients were analyzed chemically by Locke (39). In every bone analyzed except the clavicle the percentage of organic matter ranged from 42.60 to 48.54 per cent. The organic content of normal bone is about 37.83 per cent. In this group of cases the fat content usually was increased, and the content of calcium and magnesium was less than normal, diminution of calcium being the most marked.

#### PATHOLOGIC ANATOMY

##### *Gross Anatomic Changes*

Following a recent pathologic investigation, Schmorl (20, 40-43) demonstrated changes in the pelvis, sacrum, and vertebral bodies without clinical signs or symptoms comparable to those of the distinct clinical type of osteitis deformans with dis-

seminated or polyostotic involvement. Furthermore, he recognized an earlier form of the disease in which small foci, consisting of thickened trabeculae, were present in the sacrum and the lumbar vertebrae. In some instances, the foci were so small that it was necessary to use a hand lens in order to recognize them at necropsy. The final diagnosis of osteitis deformans in this group of cases was confirmed by microscopic examination. Schmorl (20) also demonstrated, following systematic examination of many skeletons, that osteitis deformans is observed most often in the spinal column and sacrum and in many instances may be confined to these regions. In cases in which the disease was confined to one vertebra, the gross and microscopic appearance of the involved regions was similar in every respect, although of a lesser degree, to that in cases in which the lesions were disseminated. Fairly commonly in those cases in which the disease was confined to one or a few vertebrae or a portion of the innominate bone, clinical evidence was entirely absent.

Schmorl's observations on involvement of bones from the standpoint of pathologic changes are comparable to those in the present study (Table IV). It is to be understood that Schmorl's work was not a controlled study of the frequency of the disease in certain bones. In many instances the presence of the disease was discovered incidentally during the course of a roentgenographic examination of the thorax, genito-urinary tract, gastro-intestinal tract, etc. Examination of all bones was not carried out in all cases.

Schmorl (20) attempted to correlate the earliest localization of the disease with the sites most subject to the mechanical effects of function and trauma. This idea was substantiated by his anatomic studies, which showed the sacrum, that part of the skeleton carrying the entire weight of the torso, to be the most frequent site of involvement. The involvement of any part of the spinal column is also in proportion to the mechanical stress to which it is subjected. The frequent involvement of

the bones of the pelvis and lower extremities as compared with those about the shoulder girdle and upper extremities adds further support to this view. As Jaffe (44) pointed out, however, the variation in the frequency with which the condition is encountered in the skull and jaw bones will have to be explained before acceptance of this hypothesis.

Osteitis deformans in the spinal column presents a variable pathologic picture. In accordance with Schmorl's description (20), the spongiosa of an involved vertebra is somewhat thickened and dense and the individual trabeculae appear dull white and lusterless. The trabeculae at the peripheral borders of the vertebral bodies appear to be more closely arranged and denser than those centrally located. The individual trabeculae are thickened and coarse. The marrow spaces in the spongiosa are variable in size, and some of them are increased considerably in dimension. Once osteitis deformans has involved any portion of a vertebra, it soon becomes entirely involved. The degree of softening of such bones may become so advanced that it is possible to cut them with a knife.

Jaffe (44) described a case in which the femur was involved and in which the periosteum was adherent to an underlying spongy cortex. The surface of the bone was irregular in contour and showed evidence of injection; exposure of the cortex disclosed it to be thickened and divided into distinct layers. Spaces were observed in the cortical bone of the femoral head and neck, which were filled with fatty marrow, thus producing cyst-like areas in the roentgenogram. Cyst-like spaces were also present in the shaft of the femur. Freund (45) described similar areas and termed them "pseudocysts."

The medullary cavity of the bone is usually widened in those cases in which there is extensive involvement. Fat-filled marrow spaces are observed in the medullary cavity surrounded by dense trabeculae similar to those already described in the cortex. The appearance of the spaces, as

demonstrated in roentgenograms, is similar to that of a cyst. In some instances the enlarged marrow cavity may extend to the articular end of the bone. In these cases, the bone end plate may be reduced to paper thinness or even be absent in some areas.

Alteration of the articular cartilage of long bones is minimal. When it occurs in osteitis deformans, it usually is secondary to malalignment and deformity. Hypertrophic arthritis may commonly be observed in association with this condition, and, when it is present, the proliferative changes at the margin of the articular surface may manifest microscopic evidence of "Paget's bone" (Freund).

*Skull:* Thickening of the calvarium, in cases of osteitis deformans, extends almost entirely outward and not at the expense of the cranial vault. The increase in the dimensions of the calvarium results from a deposition of finely fibered bone on the outer table. New bone deposited in this manner becomes transformed slowly into "Paget's bone."

Knaggs (7) described three typical stages of the disease as noted in the calvarium. Increase of size associated with great vascularity is first noted, but this subsides as sclerosis develops. The primary stage, or vascular phase, is characterized by a marked red color as a result of permeation of the new porous bone by a very vascular connective-tissue marrow. In this phase the suture lines are not yet obliterated and the frontal sinuses persist. The next phase of the disease has been termed the stage of "advancing sclerosis" by Knaggs. The outer surface of the thickened bone is smooth but is perforated by many minute apertures. The suture lines may be obliterated and the vascular markings are exaggerated. The bones of the inner table are also finely porous. The third phase has been termed the stage of "complete diffuse sclerosis." In this stage the sclerosis has advanced irregularly across the diploic zone. Recognition of the diploic zone may not be possible, particularly on the lateral aspect of the calvarium. Knaggs (7) also described sharply defined islets of ivory-

like bone on the cut surface of sections made through the skull. These islets were definitely demarcated from surrounding porous bone and manifested themselves in the roentgenogram as isolated opacities.

The term, osteoporosis circumscripta, was introduced by Schüller (46), who used it to describe a peculiar affection of the skull characterized roentgenographically by definitely demarcated zones of lessened density in the calvarium. Sosman (47) re-examined one of the cases reported by Schüller and then made a record of the results of the examination of bone obtained from the involved regions by trephination. Sosman's study was the first published account of the relation of osteoporosis circumscripta to osteitis deformans.

The circumscribed regions of osteoporosis demonstrated in the skulls of some patients are with little doubt atypical forms of osteitis deformans (Kasabach and Gutman, 24). Schmorl described 7 cases of what he termed "hemorrhagic infarction" of the skull, which most likely are examples of this form of the disease. In 5 of his cases there was evidence of the disease elsewhere in the skeleton, while in 2 cases such evidence could not be demonstrated. In his description of the microscopic picture he emphasized the engorged blood vessels observed in a fatty or fibrous marrow. He referred to the changes, which suggested vascular stasis but lacked evidence of true thrombosis. He demonstrated a bloody exudate in the marrow even though the marrow cells appeared to be normal. He also pointed out that the bone cells in the periphery of the zone would not take any stain, indicating that they had become necrotic, while adjacent marrow had good staining properties.

Involvement of the base of the skull is observed frequently and may or may not be associated with changes elsewhere in the skull. Serious alteration of the contour of the neural foramina is not common. Knaggs (7) suggested that the increase in size of the vascular foramina may be explained by the pulsation of the vessels within the foramen.



Fig. 7. "Fully developed" osteitis deformans with typical mosaic architecture. Note the fragments of lamellar bone separated by deeply stained cement lines and the absence of haversian systems.  $\times 135$ .

*Bones of the Thorax and Shoulder Girdle:* The entire sternum may be involved, but more often osteitis deformans is confined to the manubrium. Involvement of the ribs usually occurs in polyostotic cases and, as Schmorl has pointed out, the disease can be demonstrated most readily at the site of the greatest angle of the rib, that is, in the region of the axilla.

In the clavicle the disease may involve one or the other end of the bone or the changes may be more diffuse. Pathologic changes in the scapula are more likely than changes in the clavicle to be confined to a portion of the bone.

#### *Microscopic Anatomic Changes*

We must give credit to Schmorl (20) for clarifying the chaotic histologic appearance of osteitis deformans. According to his findings, the histologic examination of completely and typically transformed "Paget's bone" revealed irregular portions of lamellar bone separated by character-

istic deeply staining cement lines. Freund (45) confirmed the demonstration of these deeply-stained lines when the specimen was stained with hematoxylin. He described the typical microscopic picture of completely transformed "Paget's bone" as showing small portions of lamellar bone approximating one another like an irregular mosaic (Fig. 7). Freund emphasized the absence of haversian systems in bone that shows this typical microscopic picture.

Knaggs (7), about the same time and entirely independently, described a similar histologic picture. He commented on the demonstration of "internal curvilinear markings." His paper is well illustrated with photomicrographs which leave little doubt that his description was justified.

The typical mosaic architecture results from an intricate cycle of absorption and deposition of bone (48). Compact bone, spongy bone, and newly formed connective-tissue bone all yield to this pathologic process. The cement lines arise as the result of residue from resorption of bone previously encroached upon and are surrounded by newly deposited bone. Thus, as emphasized by Jaffe (44), the mosaic appearance is an expression of the fundamental process underlying the transformation of the original lamellar bone or the newly formed connective-tissue bone into "Paget's bone."

This typical mosaic architecture can be demonstrated only in completely transformed "Paget's bone." It is not encountered throughout the bone. In some regions, as pointed out by Schmorl, resorption is so rapid that the mosaic arrangement does not form; instead, the original bone may be replaced by connective tissue. The demonstration of mosaic architecture has been made in other diseases but to a much less degree than in osteitis deformans and not nearly so frequently. In osteitis fibrosa cystica a peculiar type of mosaic architecture is noted, particularly about the cysts and brown tumors, but the cement lines are not so irregular as in osteitis deformans.

Jaffe and Bodansky (49) showed that in

experimental chronic hyperparathyroidism the cement lines in bones were numerous but that they were fairly regular in contrast to their great irregularity in osteitis deformans.

The evolution of "Paget's bone" is much more difficult to follow in the long tubular bones than in the flat bones. Schmorl called attention to the fact that the earliest microscopic changes in a long bone are demonstrable several centimeters from the obviously involved cortex. He described the first evidence of the disease as the osteoclasts lying in Howship's lacunae within the vessel canals. As they are invaded by additional osteoclasts and blood vessels, the vessel canals enlarge and, ultimately, contiguous canals fuse and the resultant spaces become filled with connective tissue. Subsequent changes occur similar to the cycle of resorption and deposition described elsewhere.

The process which has been observed primarily in the haversian canals may lead eventually to complete transformation of the cortex into "Paget's bone." Should the process extend farther, it is characterized by periosteal proliferation and by resorption on the medullary side.

Spontaneous healing may be a common occurrence. Florid and healing processes may exist simultaneously in the same bone. Microscopic evidence of the healing process may consist in a recession of the amount of connective tissue. The fibrous marrow may be replaced by a lymphoid and fatty marrow. Additional evidence of healing may be noted in the cement lines, which may become thinner and more regular. In association with this healing process, formation of lamellar bone may be observed on a more normal basis.

#### PATHOLOGIC FRACTURES

The most frequent complication of osteitis deformans is pathologic fracture (50). In our series this was not so rare as a review of the literature would indicate. Seventy-seven pathologic fractures were noted. They affected 62 of the 367 patients. The most frequent site was in the

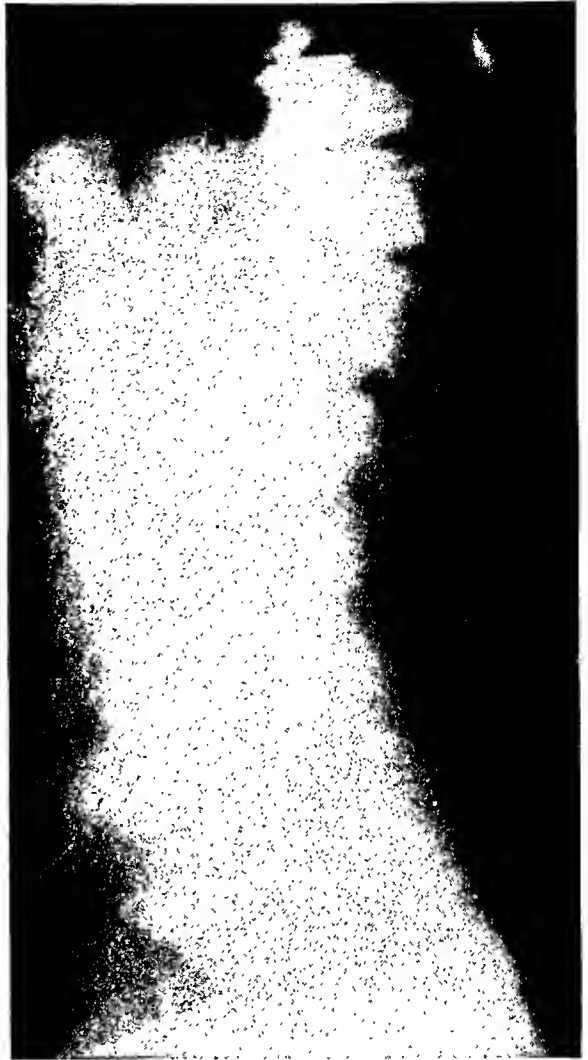


Fig. 8. Lateral view of the spinal column demonstrating extensive involvement by osteitis deformans and multiple compression fractures of the vertebral bodies.

thoracic and lumbar segments of the spinal column (Table V). All degrees of compression of the vertebral bodies were noted and in many instances there was involvement of multiple vertebrae (Fig. 8). In some cases compression may be due to softening of the bone rather than to pathologic fracture.

The weight-bearing bones are prone to pathologic fracture and are the next most frequent site of this complication. Transverse fracture without comminution was the type most often encountered; it has been likened to a broken peeled banana. Twenty-nine of the pathologic fractures in



Fig. 9. Anteroposterior view of the right femur, which shows a pathologic fracture, typical of fractures encountered in cases of osteitis deformans.

our series were located in other bones than those of the spinal column (Table V). The most common site in the femur was just below the lesser trochanter (Fig. 9).

Pathologic fracture often occurs following slight trauma and may take place spontaneously. Such fractures practically always heal with an abundant formation of callus, although in some instances delayed union has been encountered. Non-union was noted in only one of the cases included in this series—a fracture in the ischium with considerable separation of the fragments. Traver (51) reported a similar case, although in that instance the fracture was complicated by sarcoma.

As the callus goes through the various phases of calcification and ossification, it can become involved in the pathologic

process. Microscopic examination of the callus in some cases revealed evidence of "Paget's bone" (Jaffe, 44).

Incomplete fissure fractures are observed fairly frequently. Seven of this type were encountered in our series, 4 being located in the femur and 3 in the tibia. These are additional to the 77 pathologic fractures previously mentioned. The roentgen picture reveals one or frequently more fissure-like transverse lines of rarefaction on the convex surface of the bone manifesting some degree of bowing. Brailsford (22 and 23), quoting Looser, called such fractures "pseudofractures" and expressed the opinion that they were Looser zones of metaplasia. Following microscopic examination of such zones, Schmorl concluded that they represented true fissures resulting from trauma and were not areas of metaplasia. The mechanical origin of these zones was substantiated by the fact that they were frequently tender and there was a tendency for them to occur on the convex surface of the deformed weight-bearing bone. Allen and John (52) called attention to the fact that ultimately the fissures do one of two things: (1) they may go on to complete transverse fractures or (2) they may heal with minimal formation of callus.

The roentgenograms in 27 of the cases in this series complicated by pathologic fracture have been classified in accordance with the criteria discussed earlier. Twenty-three of the pathologic fractures occurred in cases classified roentgenographically as the combined form and only 4 in the sclerotic form. The observations emphasize the point, as logically would be expected, that less tendency toward pathologic fracture exists in the sclerotic form than in the combined form of the disease.

#### SARCOMA AND OSTEITIS DEFORMANS

Several isolated examples of sarcoma complicating osteitis deformans have been reported. In 1901, Packard, Steele, and Kirkbride (18) reported 66 authentic cases of osteitis deformans, in 5 of which (8 per cent) the condition was complicated by

sarcoma. In the case reported by Gruner, Scrimger, and Foster (53), osteitis deformans was complicated by formation of multiple sarcomas. DaCosta, in 1915, collected data on 213 cases of osteitis deformans. In 9.5 per cent of this group malignant disease had developed in some form. Speiser (54), in 1927, collected approximately 150 cases, in 6 of which there was sarcomatous change. Bird (55) in reviewing the records of four Boston hospitals, collected data on 64 cases, in 7 of which osteitis deformans was complicated by sarcoma. In 5 of these 7 cases the data were verified by pathologic examination. One of us (Camp, 56) reported 2 cases of sarcoma complicating this condition, seen in the Massachusetts General Hospital. Breslich (57), in 1931, following a review of the literature, presented data on 22 cases of sarcoma associated with osteitis deformans. The ages of the 22 patients ranged from thirty-two to seventy-two years; the average age was fifty-five years. Nineteen of the group were men and 3 were women.

Coley and Sharp (58) studied the problem from a different angle. They collected from the records of the Memorial Hospital and Bone Sarcoma Registry of the American College of Surgeons 71 cases in which osteogenic sarcoma occurred among patients more than fifty years of age and expressed the opinion that osteitis deformans was a predisposing factor to sarcoma in 28 per cent of the number. They concluded that, when osteogenic sarcoma is associated with osteitis deformans, it invariably develops in a bone showing the characteristic changes of the latter disease rather than in a normal bone.

In our study there were 3 instances in which sarcoma, and 1 in which benign giant-cell tumor, was a complicating factor in osteitis deformans. In all 4 cases the disease was polyostotic. The cases were briefly as follows:

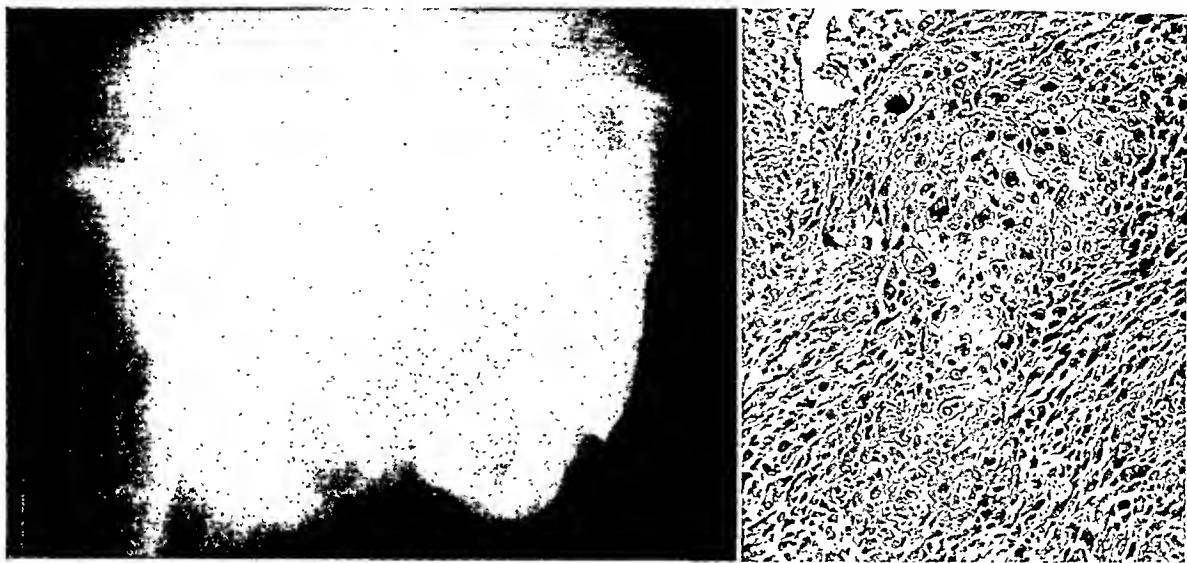
1. A woman, aged fifty-two years, had an osteogenic sarcoma arising from the lower end of the left tibia (Fig. 10). Death occurred within a year. The diagnosis of osteogenic sarcoma was confirmed at necropsy.



Fig. 10. Lateral view of left tibia. Osteogenic sarcoma involving the lower portion, originating in a bone manifesting the characteristic changes of osteitis deformans.

2. A woman, aged forty-seven years, had an osteogenic sarcoma arising from the right ilium (Fig. 11); the diagnosis was confirmed on examination of tissue removed at biopsy (Fig. 12).





Figs. 11 and 12. Osteogenic sarcoma complicating osteitis deformans. The anteroposterior view of the pelvis shows osteogenic sarcoma originating in the right ilium with characteristic changes of osteitis deformans. In the tissue from the right ilium (osteogenic sarcoma), note the neoplastic cells forming osteoid tissue. Hematoxylin and eosin.  $\times$  c. 125.

3. A man, aged seventy years, had a fibrosarcoma originating in the soft tissue of the left thigh.

4. A man, aged forty-five years, had a giant-cell tumor arising from the left ilium (Fig. 13). Surgical removal of this tumor was performed in 1920 (Fig. 14). A report from the patient sixteen years later stated that there was apparent recurrence of the tumor.

The record of one of the patients in our series stated that a sarcoma of the right maxilla had been excised elsewhere. This patient was aged fifty-seven years.

From the foregoing statements it will be seen that the sarcomatous complications of osteitis deformans usually occur in those cases in which the condition has reached an advanced stage with disseminated involvement of bone. Jaffe (44) has called attention to the fact that a tendency toward sarcomatous change sets osteitis deformans off from other dystrophic bone disease.

#### URINARY CALCULI

Urinary calculi as a complicating factor in osteitis deformans have not attracted much attention, as is evidenced by the scant reference to the subject in the literature. Twenty-two cases with this condition were encountered in our study. In 11 of the cases the calculi were found in the kidneys, in 7 in the bladder, and in 4

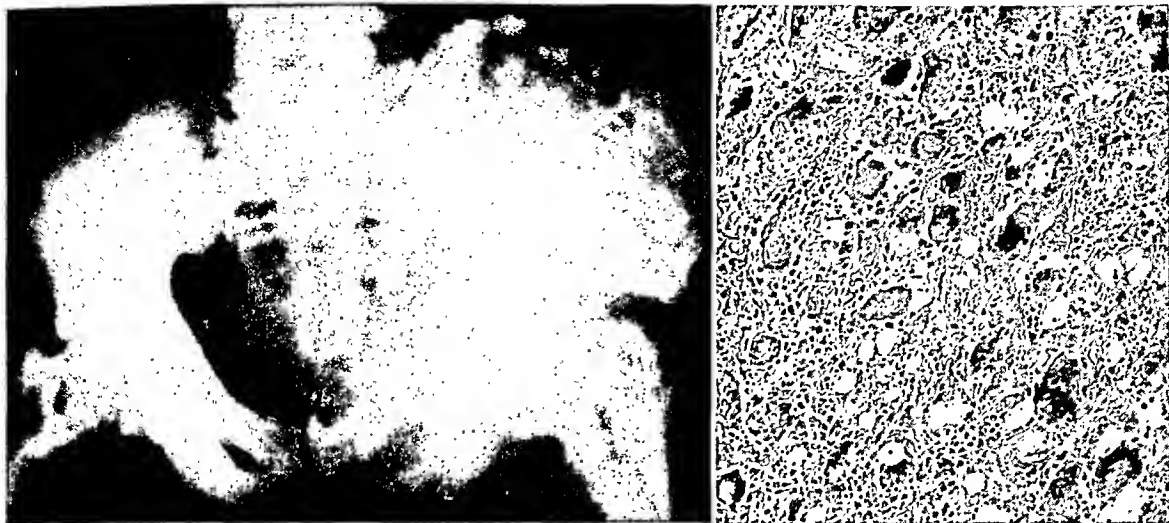
in the ureters. In several instances osteitis deformans was discovered incidentally during the course of the urologic investigation.

Six cases in which urinary calculi were associated with osteitis deformans were reported by Goldstein and Abeshouse (59). They included one case which had been reported previously by Young.

#### DIFFERENTIAL DIAGNOSIS

In the majority of cases, osteitis deformans is readily identified roentgenographically, even in those cases in which there is no clinical manifestation of the disease. The differentiation from the osteoplastic type of skeletal metastasis, particularly that secondary to adenocarcinoma of the prostate, is a problem frequently encountered. Roentgenographically these two conditions may have a marked similarity. Sutherland (21) called attention to the fact that coarse trabecular striations are usually absent in metastatic lesions. In such cases, also, expansion of the normal dimensions of the bone is uncommon, and destructive lesions are usually demonstrable elsewhere in the skeleton.

Elevation of the activity of phosphatase



Figs. 13 and 14. Benign giant-cell tumor complicating osteitis deformans. The anteroposterior view of the pelvis shows the benign giant-cell tumor originating in the left ilium. Note the extensive changes resulting from the osteitis deformans throughout the pelvic bones. In the tissue from the left ilium (benign foreign body giant-cell tumor), note the numerous giant cells of epulis type.  $\times c. 150$ .

in the serum may be as high among patients who have extensive osteoplastic metastases as it is among those who have osteitis deformans which has reached an advanced stage (31-34).

In some instances osteitis fibrosa cystica (hyperparathyroidism) may be difficult to distinguish from osteitis deformans. Any suspicion of osteitis fibrosa cystica should be confirmed or excluded by chemical and pathologic examinations. In the majority of cases the determination of the concentration of calcium and phosphorus in the serum suffices, although occasionally more complete metabolic studies are indicated.

There have been cases of osteitis deformans in which treatment for syphilitic periostitis has been carried out. The roentgenographic features of syphilitic periostitis, however, are distinct from those of osteitis deformans and should not present difficulty in the differential diagnosis.

Hyperostosis of the skull, such as leontiasis ossea, may simulate osteitis deformans. The serum calcium, phosphorus, and phosphatase are within normal limits in that condition, however, and it is of rare occurrence, with onset of the deformity dating back to childhood (Knaggs, 8).

Non-suppurative osteomyelitis of Garré may present a roentgenographic picture

somewhat similar to that seen in cases of osteitis deformans.

Cranial hyperostosis arising from meningiomas, periosteal neurofibromatosis and osteopetrosis all produce roentgenographic changes resembling those seen in osteitis deformans but usually these diseases can be excluded with certainty.

Monomelic flowing hyperostosis or melorheostosis has its onset when the patient is young and usually involves a single extremity.

Benign osteitis of indeterminate origin which is limited to one bone is encountered fairly frequently, particularly in the lumbar segment of the spinal column. Determination of the serum phosphatase is of little value in diagnosis in such cases. Benign osteitis of this type may represent atypical manifestations of osteitis deformans. The benignancy of such lesions should be verified by subsequent roentgenographic examination.

#### SUMMARY AND CONCLUSIONS

This study is an analysis of data on 367 patients seen at the Mayo Clinic prior to January 1938, for whom there had been a diagnosis of osteitis deformans.

Only once was this condition encountered in a patient less than thirty years of age.

The highest incidence of the disease occurred during the sixth decade, a third of the patients falling into this group.

A definite familial incidence was observed, 16 of the patients having 21 relatives with the same disease.

Seventy-five patients (20 per cent) had no complaints prior to the time of diagnosis and had not been aware of anything unusual so far as the osteitis deformans was concerned. The presence of the disease was discovered incidentally in the course of a roentgenographic investigation.

On the basis of roentgenologic variations, 200 cases have been classified in two groups: (1) the sclerotic phase and (2) the combined phase, 100 cases representing each type.

The most striking alteration observed in the blood of patients who have osteitis deformans is an elevation of the serum phosphatase. Higher levels for serum phosphatase were observed in those cases classified roentgenographically as the combined phase than in those in the sclerotic phase.

Pathologic fracture is one of the most common complications of osteitis deformans. Seventy-seven pathologic fractures were encountered among 62 of the patients included in this series. Pathologic fracture is most likely to occur in those cases in which the condition is classified roentgenographically as the combined phase. Healing with abundant callus nearly always takes place in this group.

In 3 cases sarcoma, and in 1 case a benign giant-cell tumor, was a complicating factor. In each instance the tumor developed in a patient suffering from the polyostotic form of the disease.

Localized or diffuse areas of finely mottled osteoporosis of the skull are thought to be an early roentgenographic manifestation of osteitis deformans (Fig. 4). This condition may be associated with diffuse zones of osteoporosis or minute opacities. In some instances the mottled osteoporosis may be the only roentgenographic evidence of the disease in the skull.

In a study of 117 cases in which there was

involvement of the skull, 26 instances of osteoporosis *circumscripta* were encountered (Fig. 5). Twenty-one of these 26 patients had associated osteitis deformans elsewhere in the skeleton. Subsequent roentgenologic examination in some instances demonstrated multiple shadows of increased density typical of osteitis deformans, which appeared in the sharply defined areas of osteoporosis (Fig. 6). From the observations of this study it would seem that osteoporosis *circumscripta* is an early roentgenographic manifestation or precursor of osteitis deformans of the skull.

Earlier authors held the view that the skull and tibia were the most frequent sites of the disease. In our series of cases, it has been demonstrated that the most frequent site of the disease is the pelvis. This high incidence of involvement of the pelvis—243 out of 307 cases (Table IV)—may be partially accounted for by the frequency with which the diagnosis was made incidentally during the course of urologic examination.

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# The Roentgen Appearance of Lobar and Segmental Collapse of the Lung

## I. Technic of Examination<sup>1</sup>

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THE ROENTGENOLOGIC demonstration of collapse of the lung and its subdivisions is dependent upon a well planned and well executed technic of examination. It is our intention to review the procedures which have been of significant value in improving the diagnosis of pulmonary lesions. In the majority of patients adequate information may be obtained from fluoroscopy and three roentgenograms: the routine postero-anterior, the Potter-Bucky or Swedish grid, and the lateral. In certain instances, however, more detailed data will be valuable or requisite.

Early diagnosis of any disease process requires the combined advantages of all medical and surgical facilities. Progress in one branch of a science demands corresponding progress in all branches. In recent years, thoracic surgery has made such rapid advances that, in order to keep pace, roentgenologic methods must be constantly reviewed and improved. Accurate localization of a gross pathologic process, as well as knowledge of its nature, clarifies both the indications for surgery and the surgical technic. Preoperative definition of a lesion to an individual lobe, or to a segment of a lobe, is important in the later decision as to the amount of lung tissue which must be saved. Lobectomy rather than pneumonectomy, segmental rather than total lobectomy, has proved feasible and desirable in certain benign processes such as bronchiectasis. This definitive type of surgery minimizes the amount of disability which almost certainly follows too great a reduction in vital capacity. Complete roentgenologic examination of the chest, which includes study of the larger subdivisions of the

major bronchi, is therefore essential if the surgeon is to be furnished the details necessary for surgical procedure.

### ROENTGEN EXAMINATION

The postero-anterior roentgenogram is the most valuable single part of the examination of the chest. Its value has been proved in large surveys in segregating the normal from the abnormal. It should be used primarily, however, as a scout film, similar to the plain abdominal roentgenogram in pyelography. If it discloses a pathologic process, fluoroscopy should be done, and a Potter-Bucky or Swedish grid as well as a lateral roentgenogram should be taken. If the diagnosis is still obscure, or if surgery is contemplated, study of the chest should be completed. A complete examination is one which gives all the information that is obtainable by roentgenography. It may require, in addition to the foregoing procedures, oblique views, particularly if the lesion is bilateral. Spot films may be as valuable in pulmonary roentgenography, especially of the major bronchi or that portion of the lung in which abnormality is suspected, as they have proved themselves to be in examination of the intestinal tract. Bronchography is of definite but limited value; laminagraphy may give information not obtained by other measures. Stereoscopic roentgenograms furnish little additional data, but they make available two films which demonstrate the chest at slightly different angles.

### ROENTGEN TECHNIC

*Fluoroscopy:* An ideal, not always attained, is that each patient should be ex-

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Name:		Date:	Age:	Unit Number:
History:				
			R	L
DIAPHRAGM:			Remarks and Sketches	
POSITION:	NORMAL _____	HIGH _____		
		LOW _____		
OUTLINE:	SHARP _____	INDISTINCT _____		
		NOT SEEN _____		
EXCURSIONS:	GOOD _____	LIMITED (IN CM) _____		
	(IN CM)	ABSENT _____		
		ABN. SLOW _____		
		EXPIR. RETURN _____		
COSTOPHRENIC ANGLES:	CLEAR _____	OBLITERATED _____		
LUNG FIELDS:	CLEAR _____	ABNORMAL _____		
HILUM:				
WIDTH:	NORMAL _____	INCREASED _____		
POSITION:	NORMAL _____	HIGH _____		
		LOW _____		
ABNORMAL PULSATION _____				
HEART:				
SIZE:	NORMAL _____	ENLARGED VENT. _____		
		AUR. _____		
		GEN. ENL. _____		
PULSATION:	NORMAL _____	RAPID _____		
		SLOW _____		
	NORMAL _____	SMALL _____		
		LARGE _____		
	REGULAR _____	IRREGULAR _____		
CALCIF		PERICARD _____		
		VALVES _____		
		CORONARIES _____		
AORTA:				
SHAPE & SIZE	NORMAL _____	TORTUOUS _____		
		WIDENED _____		
PULSATION	NORMAL _____	LARGE _____		
		CORRIGAN _____		
MEDIAST:				
POSITION	NORMAL _____	DISPLACED TO _____		
		INSPIR. SHIFT _____		
		TO _____		

CHART I: FACSIMILE OF THE FORM WHICH HAS PROVED SATISFACTORY FOR RECORDING FLUOROSCOPIC OBSERVATIONS AT THE MASSACHUSETTS GENERAL HOSPITAL



amined fluoroscopically. In large surveys, of course, this is not possible, but it can be done subsequent to the discovery of an intrathoracic lesion. The object of chest fluoroscopy is, first, to determine the dynamics; second, to determine the films necessary for the best demonstration of the lesion. Experience at this hospital has shown that fluoroscopy is best done at a relatively high kilovoltage (80 to 90 kv.p.) at 4 ma. for study of the areas of greater density, evaluation of details of the lung fields being left to later study of the roentgenogram. In our fluoroscopic tables the tube is situated approximately 15 inches back of the table top, and the output, as measured in air at the table top, is 18 r per minute. During fluoroscopy, spot films can be taken readily, and these are of great diagnostic value. They are taken at the same kilovoltage at 50 ma. No one particular system of chest fluoroscopy is best, but each examiner should develop a system of his own, whereby he covers all of the important points in the examination.

The following points as to the dynamics of the chest should be noted: motion of the diaphragm, estimated in centimeters, together with any variations, such as paradoxical motion or weakness; the position, size, and type of pulsation of the hilar shadows, which can be readily determined. The type of pulsation of the heart and aorta, as well as the regularity and rate, and the presence of intracardiac calcification, should be observed fluoroscopically, as they are not as easily demonstrated on the roentgenogram. Mediastinal shift in the respiratory phases will also be observed. During quiet breathing, the position of the mediastinum from the point of view of displacement should be noted. In the inspiratory and expiratory phases, actual shift of the mediastinum will signify definite interference with aeration in most cases. In other words, the term displacement of the mediastinum is used to describe its position as seen on the roentgenogram; inspiratory, expiratory, or respiratory shift is applied to its motion as seen during fluoroscopy. Immediately

following fluoroscopic examination the examiner should record all his findings on a form furnished for the purpose (Chart I).

*Roentgenography:* Following fluoroscopy, the requisite films are taken. A postero-anterior projection is necessary in every examination, not only for record but because minimal lesions in the parenchyma of the lung may be overlooked during fluoroscopy and may be discovered only on this film. In certain cases, a roentgenogram in full expiration may give more information than one at inspiration, but its need can usually be determined during fluoroscopy. A lateral roentgenogram should be taken of the patient in whom fluoroscopy or the postero-anterior view has demonstrated abnormality or whose history is suggestive of pulmonary disease. Although the numerous advantages of the lateral view have been stressed in the past (5), it is still not used as often as its value merits. It should be considered one of the minimum requirements in the examination of any patient known to have abnormality in the chest.

An anteroposterior Bucky film allows further study of the bronchi. It permits one to see through dense areas, thus separating a lesion from normal structures. Fluid levels may be seen with the patient in the upright position, and bone detail is more clearly demonstrated. A Swedish grid film supplies all of these advantages but the grid lines are visible. This minor disadvantage is more than compensated, however, by the ease with which the film is obtained.

With the foregoing simple procedures, it is estimated that approximately 80 per cent of patients with pulmonary disease will need no further roentgenologic study to establish a diagnosis. This is particularly true if the modified optimum kilovoltage technic is used.

If the pulmonary lesions are bilateral, or if it is desirable to study the upper posterior portions of the major fissures of each lung, oblique views will often furnish further data. The oblique view may prove as valuable in the study of the lung as it is in

CHEST EXAMINATION (300 ma.; 72 in. distance)						
Size Chest	Postero-anterior		Oblique		Lateral	
	Cm.	Sec.	Cm.	Sec.	Cm.	Sec.
Small	-19	$\frac{1}{10}$	-23	$\frac{1}{30}$	-26	$\frac{1}{20}$
Average	20-25	$\frac{1}{30}$	24-30	$\frac{1}{15}$	27-32	$\frac{1}{10}$
Large	26-29	$\frac{1}{20}$	31-33	$\frac{1}{10}$	33-	$\frac{2}{10}$
Huge	30-	$\frac{1}{15}$	...	...	...	...
	75 kv.		80 kv.		85 kv.	

CHART II: MODIFIED OPTIMUM KILOVOLTAGE TECHNIC

demonstrating the various chambers of the heart. The left lung field is seen best through the heart in the right anterior oblique, and the right lung in the left anterior oblique view. In the case of bilateral lesions, both oblique views must be taken.

Occasionally a postero-anterior or anteroposterior roentgenogram taken in the lordotic or Fleischner position (3) will define more clearly than other roentgenograms a lesion, such as collapse of the middle lobe, which has its greatest dimension more or less parallel to the plane of the major fissures. The necessity for this film may be determined during fluoroscopy by having the patient assume the lordotic position behind the fluoroscopic screen.

*Laminagraphy* has a definite place in the study of the chest, to examine the bronchi, to separate abnormal from normal structures, and to localize a lesion. Most of the findings on a laminagram, however, will have been evident before if the preceding methods are properly carried out and are correctly interpreted. Laminagraphy should not be used indiscriminately, as the patient receives a comparatively large amount of radiation (with our equipment, 12.5-13.5 r per 5 exposures, 75-80 r per min.), and it is unlikely that cavities not previously demonstrated will be brought to light.

*Bronchography* gives valuable information when it is indicated, but its indiscriminate use may frequently interfere with other essential parts of the examination, as well as with future studies to demon-

strate any progression or regression of a lesion. It furnishes the most accurate details of the bronchial tree and allows determination of a tumor, stenosis, or bronchiectasis. In bronchiectasis it serves as a map to guide the surgeon in regard to the amount of lung which can be, or must be, removed at operation. It is, however, time-consuming, and in the majority of cases will offer little further diagnostic information than has already been obtained from fluoroscopy and the roentgenograms already discussed.

Adams and Davenport (1) have described the steps necessary for complete examination of the bronchial tree. A satisfactory rule in bronchography is to instill the iodized oil into the bronchi of the involved side of the chest first, after which postero-anterior and lateral roentgenograms are taken. If there is any question of tumor or other type of stenosing bronchial lesion, spot films also should be taken at this time. The opposite side of the bronchial tree is then filled, and postero-anterior, right anterior oblique, left anterior oblique, and Bucky anteroposterior roentgenograms are taken.

*Artificial pneumothorax* followed by roentgenography, although it constitutes a minor surgical operation, in some cases furnishes information of value sufficient to offset the risk of the procedure. Its use is indicated when it is difficult to determine the origin of a lesion, that is, whether it arises in the parenchyma of the lung, in the mediastinum, or in the chest wall. In the absence of pleural adhesions, the lung will

separate readily from the chest wall or mediastinum, allowing the exact location of the mass to be demonstrated. It is sometimes necessary after the induction of artificial pneumothorax to take anteroposterior or postero-anterior roentgenograms in the lateral decubitus position.

#### FACTORS AFFECTING THE QUALITY OF ROENTGENOGRAMS

Certain relatively new factors produce roentgenograms of better diagnostic qual-

optimum kilovoltage technic, as publicized by Fuchs (4), can readily be adapted to examination of the chest, and with modifications permits the obtaining of excellent films at 6-foot distance. The higher kilovoltage used with this technic will give a film showing less contrast, but this disadvantage is offset by the production of one in which all parts of the chest are sufficiently exposed for diagnostic purposes (Fig. 1). Lesions in the mediastinum and behind the heart, not visible on a contrast

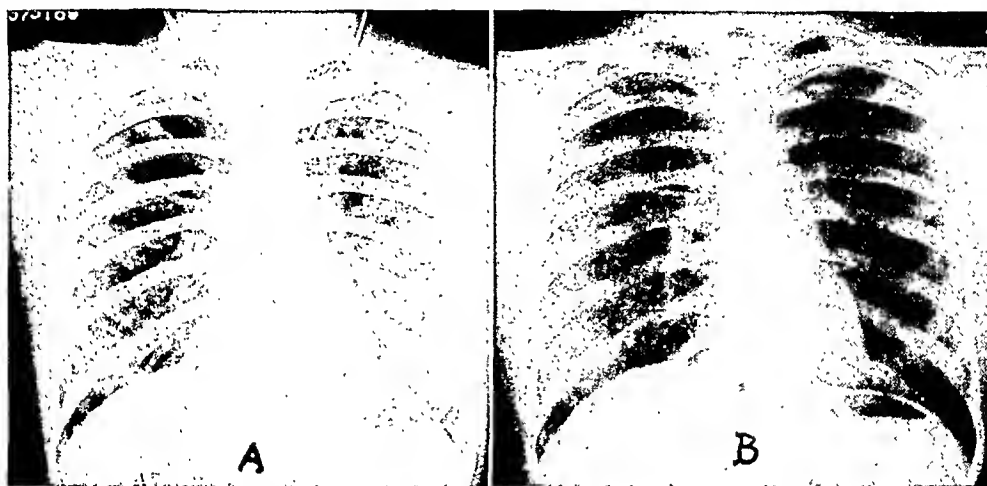


Fig. 1. A. Variation of kilovoltage dependent upon the thickness of the part. B. Modified optimum kilovoltage technic. With this technic, all parts of the chest are more equally penetrated, confusing shadows are lost, and the left lower lung behind the heart is visualized. (Further illustrations of the different diagnostic procedures have not been included because many of them will be demonstrated in subsequent papers.)

ity than formerly, and they should be used to the greatest advantage. The rotating anode tube, although not particularly new, has in the past ten years proved itself worth while. It allows use of high kilovoltage at high milliamperage with a relatively small focal spot. The higher kilovoltage permits better penetration of the area under examination and more uniform exposure, while maintaining a 6-foot target-film distance. The high milliamperage allows shorter exposure time and minimizes the loss of detail due to motion. The small focal spot aids in giving maximum detail. A phototimer (6), or a device of similar type, may become universal in the future, but at the present time its advantages are somewhat limited. Intensifying screens of relatively small crystal size and cassettes with good contact are recommended. The

film of the past, become much easier to recognize. Satisfactory lateral projections are also obtained at 6-foot distance with the modified optimum kilovoltage technic, and at this distance better detail is secured and less radiation is scattered. This modification of the optimum kilovoltage technic described by Fuchs (Chart II) has been of significant value in producing films of uniform quality and with great diagnostic potentialities.

#### SUMMARY

Roentgen examination of the chest, consisting of fluoroscopy and three roentgenograms, is technically easy to accomplish and is economical. Its diagnostic possibilities are manifold, and in the majority of cases it will give all the necessary information.

Certain patients will require additional procedures, which are described.

The importance of the rotating anode tube, of the fundamental factors of good technic, and of utilization of the modified optimum kilovoltage technic has been stressed.

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# Bone Lesions of Congenital Syphilis in Infants and Adolescents: Report of 46 Cases<sup>1</sup>

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THE MAIN objective in this review of 46 cases of congenital syphilis has been to analyze and evaluate the roentgenographic findings. The material was collected at the State University and Crippled Children's Hospitals. It includes 19 males and 27 females; 32 white and 14 colored patients. Their ages ranged from the newborn child up to nineteen years. Twenty patients were older than one year, and 26 were younger. Of the latter group, 20 were less than five months of age. Serologic tests were reported positive in 43 cases, negative in 2, and in 1 case the specimen was destroyed. The cerebrospinal fluid was examined 16 times and found positive in only 1 instance. For the sake of brevity, we have intentionally omitted from consideration stillbirths and syphilitic fetuses.

TABLE I: TYPES OF BONE LESIONS

All cases.....	46
Periostitis.....	42
Osteochondritis.....	21
Osteitis.....	17
Osteomyelitis.....	11
(Pathological fractures, 5)	
Cases in children under one year.....	26
Osteochondritis with periostitis.....	16
Periostitis.....	5
Osteochondritis, periostitis, and osteomyelitis..	2
Osteochondritis.....	1
Osteochondritis, periostitis, and osteitis.....	1
Periostitis and osteitis.....	1
(Pathological fractures, 2)	
Cases in patients over one year.....	20
Osteitis and periostitis.....	10
Osteomyelitis and osteitis.....	3
Osteomyelitis and periostitis.....	3
Osteomyelitis, periostitis, and osteitis.....	2
Osteomyelitis, periostitis, and osteochondritis..	1
Periostitis.....	1
(Pathological fractures, 3)	

Although many of these patients were examined in our Outpatient Department and only brief records were available, the following clinical findings were noted: snuffles and skin rashes in 13 cases; pseu-

doparalysis in 11; adenopathy, enlargement of the liver and spleen in 10; saber shin in 10; keratitis in 3; and draining bone lesions in 2. In 3 patients pyogenic osteomyelitis was suspected; scurvy in 2; Ewing's tumor in 2; osteogenic sarcoma in 1; sickle-cell anemia in 1; Hodgkin's disease in 1; neuroblastoma in 1.

In reviewing the x-ray findings, the bone lesions were listed individually as shown in Table I, although in the great majority of cases a combination of lesions was present. Thus, periostitis could be detected in 42 cases, osteochondritis in 21, osteitis in 17, and osteomyelitis in 11. There were 5 pathological fractures in the entire series. As appears from the table, the most prevalent lesion in very young infants was osteochondritis with an associated periostitis. The incidence of periostitis as the sole lesion was approximately one-third as high. Two pathological fractures were observed in this group. In older children, osteitis and osteomyelitis, associated with lesions of other types, occurred in almost equal proportions. Among these older patients there were 3 pathological fractures.

## OSTEOCHONDRITIS

In syphilitic infants of less than one year of age, the pathognomonic lesion seen on roentgen examination is osteochondritis, accompanied in most instances by periostitis. These lesions tend to have a symmetrical distribution, although they vary considerably in appearance and extent. In severe cases the destructive process is so extensive about the growing ends of the long bones that metaphyseal fractures occur. It is this type of involvement that is responsible for the clinical picture of Parrot's pseudoparalysis. In

<sup>1</sup> From the Department of Radiology (John E. Heatley, M.D., Director), University Hospitals of Oklahoma School of Medicine. Accepted for publication in September 1944.



Fig. 1. Case 1: Extensive osteochondritis, periostitis, and osteomyelitis. Dentate appearance of the radial metaphyses, and metaphyseal separation of right femur.

other cases the metaphyses have a "zig-zag" or "saw-tooth" appearance, while in milder cases only a portion of the metaphysis is involved.

All of the above lesions are considered pathognomonic. When, however, osteogenesis is interfered with to a lesser degree, the x-ray findings are considered as merely suggestive of syphilis. If calcium utilization becomes unbalanced, a sclerotic zone or cap is seen at the metaphyseal portion of the shaft. In other cases, a zone of rarefaction develops. In still others a sclerotic zone with an adjacent zone of rarefaction may be found. In still others cases of osteochondritis are accompanied by a generalized periostitis, the most probable diagnosis is congenital syphilis of bone. In differential diagnosis, birth injuries, rickets, scurvy, and osteogenesis imperfecta must be considered. It is not

uncommon for syphilitic babies to suffer from gastro-intestinal disturbances, so that an avitaminosis may coexist. Of the 26 children less than one year of age in our series, 20 gave evidence of osteochondritis of one form or another.

**CASE 1:** B. J. B., a two-month-old colored girl, was seen because of impaired motion of all the extremities. The onset of these symptoms had been three weeks previously. The mother had received two antisyphilitic injections during the prenatal period. The child's legs were swollen and held flexed on the thighs, and it cried out when any movement of the arms or legs was attempted.

X-ray films of the long bones showed extensive osteochondritis, periostitis, and osteomyelitis involving the tibiae, femora, and radii (Fig. 1). The metaphyses had a dentate appearance and metaphyseal separation had occurred. Blood Wassermann, 4 plus. *Diagnosis:* Congenital syphilitic bone lesions.

**CASE 2:** R. J. G., a month-old colored male, was brought in because of moderate swelling of the hands

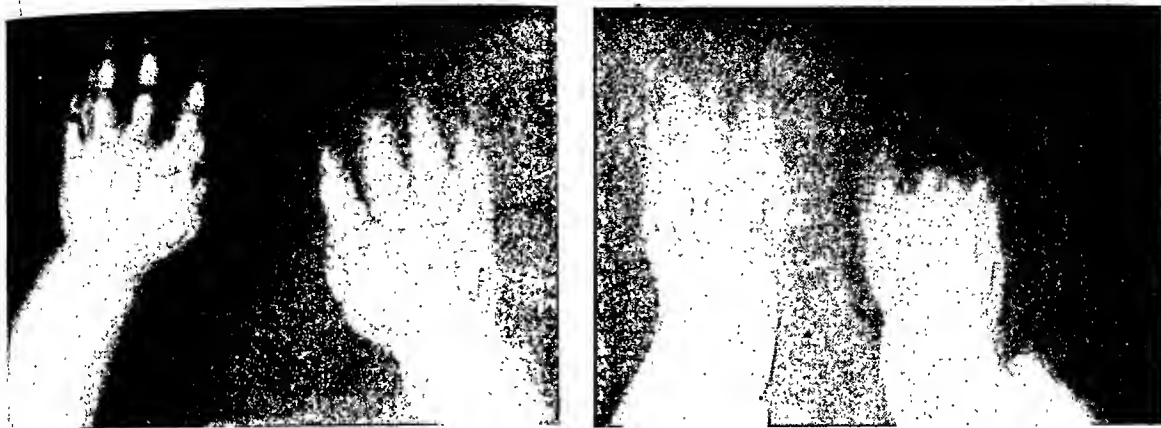


Fig. 2. Case 2: Osteochondritis and periostitis of bones of the hands and feet. The long bones of the extremities showed similar changes.



Fig. 3. Case 3: Generalized periostitis of the long bones of the extremities.

and feet of three days' duration. This was the only positive physical finding. The blood Wassermann reaction was 4 plus. Both mother and father also had positive serologic reactions. X-ray films of the extremities showed osteochondritis and periostitis of the long bones. The hands and feet showed similar changes (Fig. 2). *Diagnosis:* Congenital syphilitic bone lesions.

#### PERIOSTITIS

Periostitic lesions may occur in young babies as well as in older children and adolescents. Like osteochondritis, periostitis may show considerable variation. In some cases it is seen roentgenographically as a thin linear shadow, or it may be more





Fig. 4. Case 4: Pathological fracture of left fibula with several layers of periosteal thickening. Osteitis of right tibia.

extensive so that several thick layers are present. In the later cases, it is associated with an underlying osteomyelitis, forming an involucrum, and has been referred to as the coffin type. In 5 cases in our series, all in babies under five months of age, the sole lesion identified on the x-ray films was a generalized periostitis of the long bones. As stated previously, if any type of osteochondritis is present, together with a symmetrically distributed periostitis, congenital syphilis is the most probable diagnosis. In older children, the periosteal reaction may serve only to mislead us. The onion-skin appearance, sharply broken off, perfectly imitating a Codman's triangle, gives one the immediate impression of a primary bone tumor. In such cases x-ray films of all the long bones become invaluable, as an associated osteitis will give a clue to the correct diagnosis. Periostitis was present in 42 of our 46 cases—25 times in children under one year and 17 times in the older group.

CASE 3: K. M., a five-month-old white male, was seen because of convulsive seizures of a week's duration. Physical examination was essentially negative. Films of the long bones showed a periostitis symmetrically distributed, with some rarefaction of the metaphyses (Fig. 3). Blood Wassermann and cerebrospinal fluid tests were positive. *Diagnosis:* Congenital syphilis of bones.

CASE 4: J. G., an eight-year-old colored girl, complained of swelling of the left leg of four to five months' duration, which was painless and progressive. No other complaints were mentioned. Examination revealed erosion of the soft palate and generalized lymph node enlargement. The left foreleg was swollen, edematous, and non-tender. Roentgenograms disclosed a pathological fracture of the proximal third of the shaft of the left fibula with fusiform expansion and thickening of that portion of the shaft (Fig. 4). There were numerous periosteal layers showing moth-eaten spaces. The medullary canal was also involved. In spite of a positive serologic test, a diagnosis of Ewing's tumor was made. Biopsy was reported as favoring a syphilitic infection. Additional films, of the opposite leg, showed an osteitis of the right tibia which brought the x-ray findings more in keeping with the positive serologic reaction.

#### OSTEOMYELITIS

Although osteomyelitis is occasionally found in infancy, it is more prevalent in older syphilitic children. It may occur as a single lesion or in a more generalized form, as in the pyogenic type. We have limited the term *gumma* to localized areas of destruction within bones showing an osteitis, realizing that this distinction is purely arbitrary. In any case of syphilitic osteomyelitis, the pathologic process is the same, consisting of invasion and replacement of osseous elements by granulation or fibrous tissue. Pathological fractures occur not infrequently in these cases and often are multiple. In the older children, these lesions are thought to be due either to inadequately treated or untreated bone syphilis of early childhood. In this series only 2 cases of osteomyelitis were found in the group under one year of age; 9 cases occurred in the older children.

CASE 5: L. M., a seven-year-old white girl, was first seen on Jan. 7, 1940, because of swelling of the abdomen and cervical lymph nodes. These symptoms were of several months' duration. This child had been sickly since birth. Six weeks before admission, following a sore throat, the lymph nodes

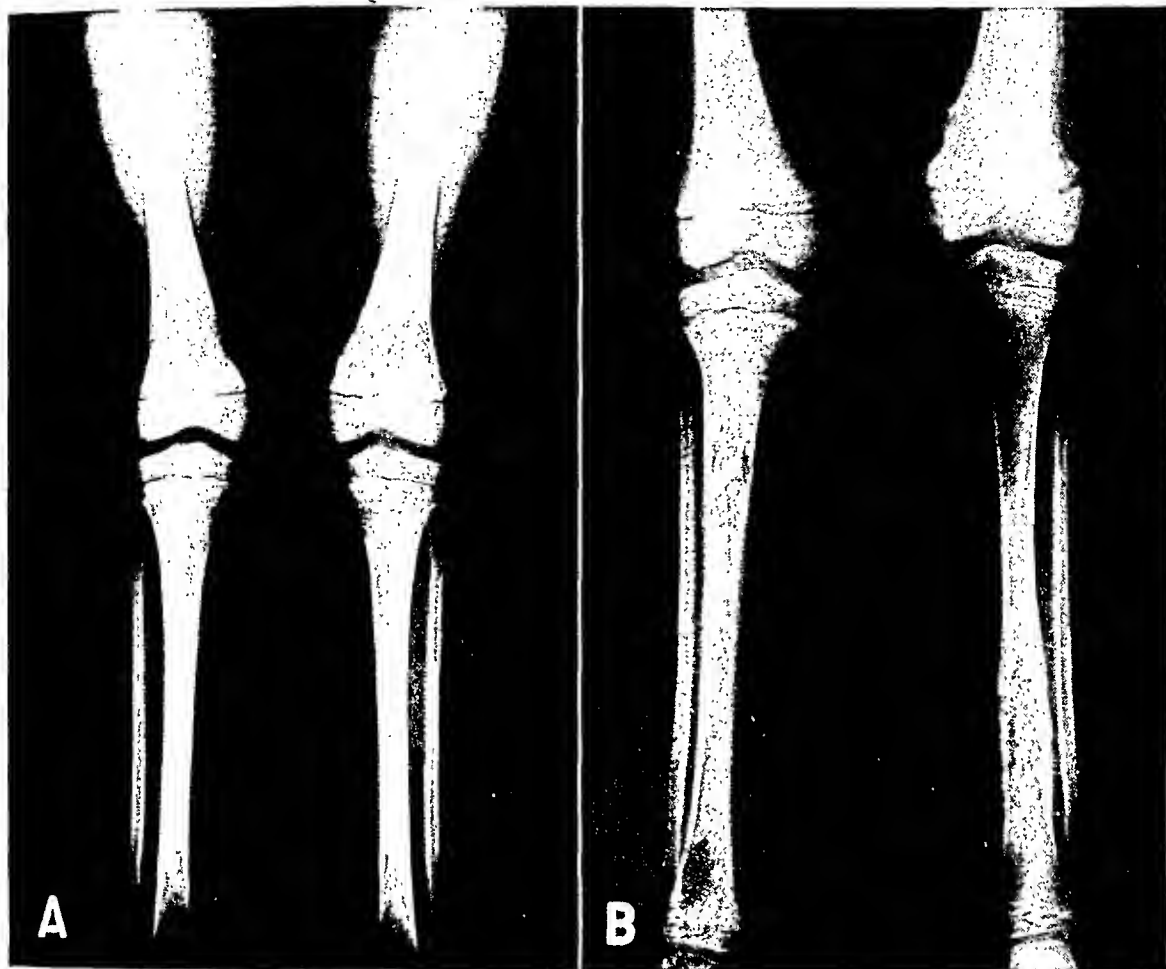


Fig. 5. Case 5. A. Destructive lesions of the left femoral metaphysis (Jan. 16, 1940); the right ulna was similarly involved. In spite of adequate antisyphilitic treatment, the blood Wassermann reaction remained positive. B. Roentgenograms made Oct. 24, 1940, showing bone lesions to be more extensive and numerous. In several bones the epiphyses also became involved.

of the neck became swollen. Pinworms had been found in the stools from time to time for the past five years. At the age of three, the child became blind, but there had been some improvement in this respect.

The child looked anemic, undernourished, and chronically ill. Cervical and axillary adenopathy was present. The liver and spleen were moderately enlarged. The pupils were small and reacted sluggishly to light; the cornea appeared hazy. Clinically, the case was considered one of Hodgkin's disease, leukemia, or tuberculosis. The blood findings were as follows: hemoglobin 50 per cent; red cells 3,600,000; white cells 7,400 (neutrophils 37 per cent, eosinophils 6 per cent, stab forms 27 per cent, lymphocytes 33 per cent, monocytes 2 per cent); platelets 378,000. The blood Wassermann reaction was positive, the cerebrospinal fluid reaction negative. A lymph node biopsy was reported as showing a low-grade fibrosing type of tuberculosis. The chest film revealed moderate widening of the

upper mediastinum due to lymphadenopathy, with no evidence of cardiac or pulmonary disease. The long bones of the extremities showed destructive lesions involving the shafts of the right ulna and the distal third of the left femur (Fig. 5, A). Later, similar lesions developed in the neck of the left humerus, crossing and involving the proximal epiphysis, in the distal end of the right humerus, several of the ribs, and both tibiae. Due to the progressive and destructive nature of the bone lesions, with extension into the epiphyses, a diagnosis of neuroblastoma was made. A biopsy specimen taken from the tibia was reported as showing a chronic interstitial osteitis with fibrosis, probably tuberculous or syphilitic. In spite of adequate antiluetic therapy, the blood Wassermann remained positive and the bone lesions became more widespread (Fig. 5, B). Several pathological fractures occurred. When last seen, on Jan. 26, 1941, the patient was up and about on crutches. The liver and spleen had decreased in size and her general condition was im-

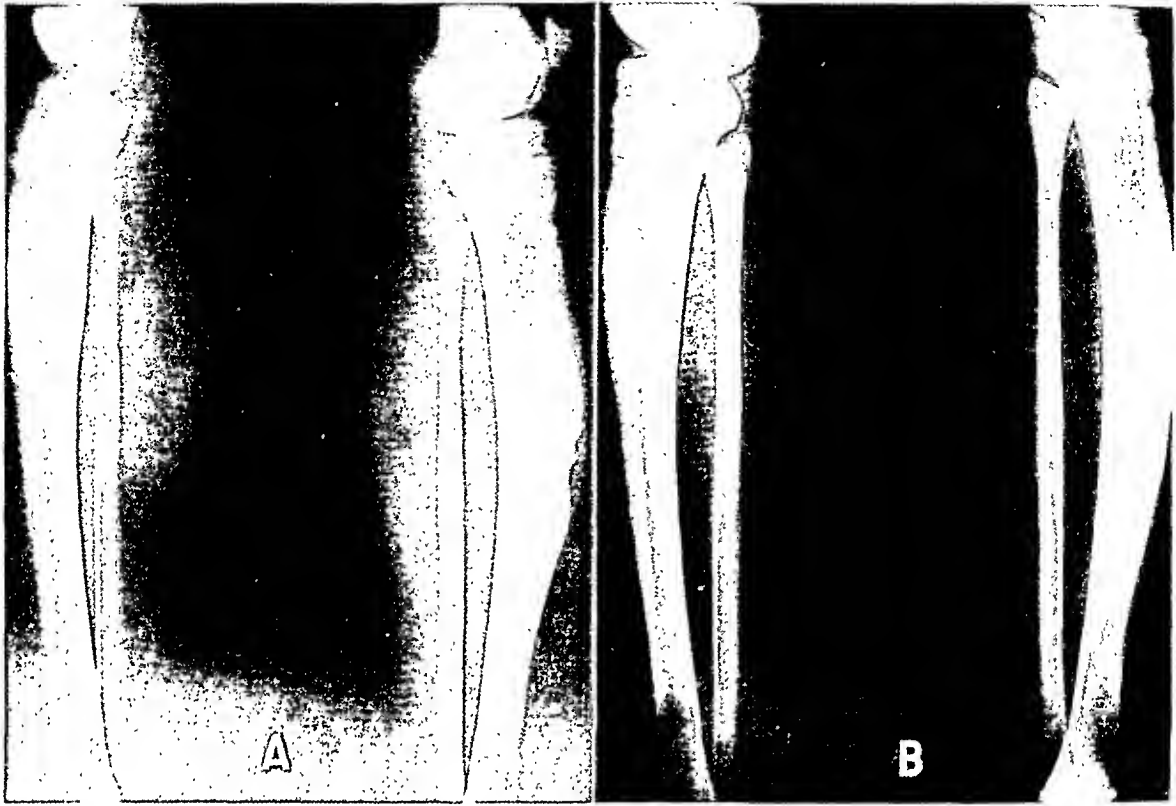


Fig. 6. Case 6. A. Moderate thickening of the cortices of the tibiae, with increased density and anterior bowing; localized areas of destruction due to gumma. B. Regression of gumma following antisyphilitic therapy; osteitis persists.

proving gradually. *Final diagnosis:* Syphilitic osteomyelitis and epiphysitis.

#### OSTEITIS

Syphilitic osteitis is found almost exclusively in the older child. Although usually bilateral in distribution, it may vary considerably in degree on the two sides and in different bones. The tibiae are most frequently involved and give the clinical picture of saber shins. Among 20 children over one year of age, osteitis was noted in 13. The cortical bone on the x-ray films is thickened and of increased density. As a result of softening, however, an anterior bowing occurs. Osteitis may affect bones of the hands and feet, producing the syphilitic spina ventosa. When localized areas of destruction are found within these areas of osteitis, a gumma or a localized osteomyelitis forms. Under adequate antisyphilitic therapy these lesions heal rapidly, whereas incision and drainage lead to difficulties and embarrassment.

Diagnosis of syphilitic bone lesions in

the older child on the basis of the roentgen evidence is more difficult than in young babies. Pyogenic osteomyelitis, scurvy, blood dyscrasias, primary and metastatic bone tumors, may be suspected.

**CASE 6:** A 16-year-old white boy was examined for swelling of both forelegs. The swelling first appeared over the left shin four months previously, and two months later the right became involved. Physical examination showed rhagadiform skin about the mouth and swelling over the anterior surface of the shins, which was painless on pressure. X-ray films revealed a moderate thickening of the cortices of the tibiae (Fig. 6, A), most marked on their anterior surface, where bowing of the shafts had occurred. A localized area of destruction, surrounded by a zone of sclerotic bone and thickened periosteum, was present in each tibia. Serologic blood tests were positive; the cerebrospinal fluid was negative. *Diagnosis:* Syphilitic periostitis with gumma. Under antisyphilitic therapy the gummatous lesions regressed, but the osteitis persisted (Fig. 6, B).

#### DISCUSSION

It may be worth while to repeat some of the better known facts concerning con-

genital syphilis of bone. Pathognomonic lesions have been found in fetuses as early as the fifth month of gestation (5). In a newborn child, therefore, roentgenographic examination may reveal typical findings, so that an absolute diagnosis can be made. Syphilitic infants that develop bone lesions do so in the first four months of life and these lesions tend to regress or heal spontaneously after that period (1, 2, 4, 6, 8). The osseous changes can be best examined and studied in the long bones of the extremities. They tend to assume a symmetrical distribution and most frequently involve the tibia, ulna, radius, femur, humerus, and fibula in the order named. The fact that these pathological changes are so clearly demonstrable on films is due to invasion and replacement of normal tissue by granulation and fibrous elements. In very young infants the sites of predilection are those where osteogenesis is most active and this interference with normal bone growth affects the appearance of the metaphyses.

Adequate prenatal antisyphilitic therapy does not insure the mother that her baby will not have syphilis, although the incidence is much lower than when the prenatal therapy is inadequate. The highest incidence is observed in those cases where no treatment at all has been administered (9).

In older children, syphilis becomes the "great imitator" and may simulate any type of bone lesion known. Serologic tests of the blood are positive in such a high percentage of cases that its examination is indispensable in confirming the x-ray diagnosis.

Syphilis rarely involves a single bone. In his criteria for making a diagnosis of a primary carcinoma of bone, Bloodgood includes serologic tests and x-ray examination of the entire skeleton. This applies equally well to syphilitic bone lesions.

It has been shown by many previous and similar studies that the bone lesions of congenital syphilis can be accurately determined by roentgenographic studies and that this method is not excelled even by

microscopic examination. Syphilis in its tertiary stage is fundamentally a disease affecting the blood vessels, and visceral changes can be traced to disturbances of the circulatory system. In young infants, syphilitic infection becomes most evident in the growing portions of bones, where circulation is being established as a step in osteogenesis. Osteochondritis develops proximal to the epiphyseal cartilage. At a less rapid rate, bones also grow in width under the periosteal and endosteal layers. Thus, a periostitis may represent disturbances in osteogenesis and may be an initial lesion rather than representing the healing stage of the process, as suggested by McLean (6), or a stripping of the periosteum by a serous exudate formed at the site of osteochondritis, as suggested by Hodges *et al.* (4). Of the 46 cases here analyzed, only 4 failed to show any evidence of periostitis, and in 5 cases, all under one year of age, the sole lesion found was a generalized periostitis. Brailsford (2) states that periostitis appears more often in children after the third month of life. In this series there were 8 children under that age and periostitis was found in all except one, who died on the fourth day of life.

Periostitis is the most frequent type of bone lesion in congenital syphilis, regardless of age, and should be carefully sought, although its detection on films often is an easy matter. A generalized periostitis of the long bones before the age when scurvy and rickets usually develop should be considered syphilitic until proved otherwise. It is important, however, to keep in mind that this same finding may occur in non-syphilitic lesions. Caffey (3) found it in cases of healing rickets especially in premature infants, rapidly growing normal infants, pyogenic osteomyelitis, erythroblastic anemia, traumatic ossifying periostitis of the newborn, and even in congenital heart disease. In the older child, the periostitis is usually associated with underlying bone disease, such as an osteitis or osteomyelitis. Examination of all the long bones of the extremities in these cases will

help considerably in arriving at the correct diagnosis. It is not unusual in cases of this type to conduct the roentgenographic examination on the same day the blood is obtained for a Wassermann test. The films can be examined shortly after development so that the x-ray diagnosis may precede the serology report by several days, and the diagnosis made so much sooner. By this method, the diagnosis may be established even in cases with negative blood findings.

#### CONCLUSIONS

1. Bone lesions of 46 syphilitic children ranging from the newborn up to the age of nineteen years were analyzed and studied.
2. The highest incidence was found in infants less than five months of age and the predominant osseous lesions were a generalized osteochondritis and periostitis.
3. Generalized periostitis may be the sole lesion, representing a disturbance in the osteogenesis responsible for the growth in *width* of the shaft of long bones; disturbance of growth in the *length* of the shaft produces an osteochondritis.
4. In children after the first year, osteitis and osteomyelitis were the most frequent lesions found, usually associated with a periostitis.
5. Roentgenographic examination con-

stitutes not only an excellent method for making the diagnosis, but also gives an accurate picture of the type and extent of the bone changes.

6. In suspected cases, films of all of the long bones of the extremities are indispensable.

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# Idiopathic Spontaneous Pneumothorax: History of 100 Unselected Cases<sup>1</sup>

CAPT. LOUIS SCHNEIDER, M.C., A.U.S., and I. I. REISSMAN, M.D.

THE WRITERS have been impressed by the frequency with which a history of spontaneous pneumothorax is obtained from selectees in the 18- to 38-year age group appearing for induction examination. About one in five hundred men gave a verified history of this condition.

That so-called idiopathic spontaneous pneumothorax rarely results in pulmonary tuberculosis is now well known (1-4). Many of the men who had suffered such pulmonary collapse in the past, however, were unduly alarmed about it, having been advised unnecessarily to lead a cautious, sedentary life. Some even exhibited functional chest symptoms bordering on conversion hysteria, probably because the physician who treated them for the pneumothorax viewed this accident as a catastrophe and the subsequent existence of the patient as hazardous.

We believe that these cases should be treated like the accidents they really are. Once the patient has recovered, nothing more serious will happen than a possible recurrence of collapse, after which, as a rule, a subsequent attack is uncommon. Invalidism or chronic lung disease is rarely a sequel.

The following data are based on 100 unselected cases of spontaneous pneumothorax observed months to years after collapse. The clinical histories were verified by certified letters from physicians who originally treated the patients and in many instances by x-rays taken at the time of the treatment. One of us (L. S.) carefully reviewed the induction chest films in each case to ascertain the condition of the lungs, keeping special watch for evidences of bullous emphysema and areas of fibrosis or infiltration.

*Lung Involved:* The right lung was involved in 55 cases, the left lung in 44. One patient gave a history of bilateral pneumothorax.

*Age Incidence of Initial Pneumothorax:* In no instance was there a history of pneumothorax before the age of sixteen. Twenty-three cases occurred between the ages of sixteen and twenty; 34 cases between the ages of twenty-one and twenty-five; 29 between twenty-five and thirty, and 14 between thirty-one and thirty-five years. The accident would thus appear to be most common in the third decade of life, as has been reported by others.

*Recurrences:* There were 19 recurrences in this series. Discounting 6 cases in which a spontaneous pneumothorax was first shown on our own films at the time of examination, the percentage of recurrences was about 20.

All except two recurrences were on the same side as the original pneumothorax. There was no recurrence before the age of twenty, and only one beyond the age of thirty. In 7 cases recurrence was within one year after the initial pneumothorax; in 3, two years later; in 1, three years later; in 2, four years later. There was 1 recurrence five years and 1 nine years after the initial attack. Three instances of multiple recurrence were seen: in 1 case, one, two, and three years after the first attack; in 1, two and seven years later; and in the third after several intervals of unstated length. The chance of recurrence appears to be only about 10 per cent if two years have elapsed since the initial pneumothorax.

*Activity at the Time of Spontaneous Pneumothorax:* As far as could be ascertained, none of these men had suffered

<sup>1</sup> From the Armed Forces Induction Station, Second Service Command, Grand Central Palace, New York, N. Y.  
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from chronic bronchitis, asthma, or pulmonary tuberculosis at the time of the spontaneous pneumothorax. Except for the few who had had colds, all were in good health. In the majority of cases—63—the pneumothorax occurred during slight physical activity. In only 30 did it develop during intense physical exertion, as in lifting a heavy weight or rapid running. Of the 6 men in whom the condition was discovered at the Induction Station, 5 were asymptomatic and were surprised to learn of its presence. The sixth had experienced severe direct trauma to the chest earlier in the day. In some, typical symptoms of sudden chest pain and dyspnea had appeared as they were walking slowly, eating, shaving, sleeping, or standing or sitting quietly. Direct trauma to the chest without rib fracture accounted for 4 cases. The forced expiration of coughing associated with an acute upper respiratory infection was responsible for 6 cases; 1 followed a spell of sneezing; another, an attack of vomiting.

*Racial Factors:* In this series there were 97 white men, 2 Negroes, and one Chinese. This represented a marked disproportion as compared with the ratio of white to colored men examined at the Station. In one of the Negroes the pneumothorax was asymptomatic and discovered only on the induction film; the other Negro was a hospital orderly. Although we have seen over 200 men with histories of pneumothorax, we have been impressed by the rarity of this accident in the colored race. We have no reason to believe, however, that the occurrence of spontaneous pneumothorax is or should be less among blacks than whites; rather we feel that the former are less sensitive to the symptoms of the condition than the latter, and that, for that reason, the pulmonary collapse goes undetected and unrecorded. There are, of course, some men among both blacks and whites who have no symptoms, like the 5 per cent in whom pneumothorax was first seen at the Station on routine examination. They will run through the gamut of spontaneous

pneumothorax to re-expansion without ever being aware of the condition.

*X-Ray Findings:* Sixty-five men of this series were seen two years or more after re-expansion of the collapsed lung, and some more than ten years later. It is an impressive fact that the chest films in these cases appeared perfectly normal except for 4 instances cited below. In other words, from the appearance of the film, we could not determine whether a spontaneous pneumothorax had occurred in the past, nor could we predict that one would be likely to recur in the future. On the other hand, one of us (L. S.) has seen numerous cases at the Induction Station, of bullous emphysema, some confined to the apex or apices and others involving half the lung field unilaterally or bilaterally, without any history of spontaneous pneumothorax.

The positive findings in the 4 cases in our series were as follows:

1. Bullous emphysema of both apices, more marked on the right side, in a selectee who had had a right spontaneous pneumothorax with recurrence on the right side four years later.

2. Bilateral thickened apical pleura in a selectee who had had partial pneumothorax on the left side four years before.

3. Marked residual pleural thickening in a man who had had a spontaneous hemopneumothorax on the left side two years before. Another man in the series, who had had a pneumothorax three months before, with aspiration of bloody fluid from the left chest, showed no residual pulmonary or pleural changes.

4. Productive lesion at the periphery of the left upper lobe, above L-2, in a man who had had a spontaneous pneumothorax on the right side five years before.

*Clinical Aspects and Attitude of Selectee in Regard to Pneumothorax:* Complete statistical data as to the clinical aspects of pneumothorax are not available in this series. Pain or a "queer feeling" in the chest and respiratory distress on effort were the outstanding symptoms at the time of the accident. Sometimes, because of the pain, the chest had been strapped



after a diagnosis of pleurisy was made, the true condition being determined later, following roentgenography or fluoroscopy. In not a few instances, especially in the older men, when the pain was in the left chest and associated with distress, a diagnosis of angina pectoris or coronary occlusion was made. The treatment usually consisted in keeping the patient in bed several weeks and allowing him to return to work, presumably after a short period of observation following re-expansion. One man with a total pneumothorax on one side returned to work three weeks after the diagnosis was made, while another, with a one-third collapse of the right lung, was allowed to return to his job four months later. Some went to work within a month after the occurrence of spontaneous pneumothorax while others did not resume their duties for six months to a year. The average length of "disability" was about three to four months. In "compensation cases," as a rule, absence from work was more prolonged. A common complaint of selectees who had spontaneous pneumothorax was occasional dull to sharp pain on the side of involvement, usually not related to effort.

Many of the men had been told—and some brought letters from their physicians to the same effect—that because they had experienced a spontaneous pneumothorax they were not to indulge in exercise, sports requiring exertion, or hard physical labor. Some selectees in whom the accident had occurred many years ago had been thus cautioned lest pulmonary tuberculosis develop. A few, in whom the pneumothorax was of more recent date, were so instructed because of the possibility of recurrence, and many others had been advised to lead an almost sheltered life, without explanation. It was refreshing to see some, however, who had been told to forget about their pneumothorax, once re-expansion had taken place, and to indulge in all normal activities. Not infrequently, a letter from the selectee's doctor urged a cautious, almost vegetable existence, despite the fact that the spontaneous pneumothorax had occurred during no more superhuman

physical effort than reading a book, shaving, or sleeping.

#### ILLUSTRATIVE CASES

**CASE 1:** *Spontaneous Pneumothorax, Asymptomatic, Discovered at Induction Examination.* A white selectee, aged 36 and in good health, reported for induction examination on Sept. 9, 1943. A spontaneous left-sided pneumothorax with 85 per cent collapse was discovered on the routine chest film. The man was asymptomatic at the time and recalled no undue exertion or trauma to the chest within the preceding days. After routine home care, he returned to work several weeks later. He appeared at the Station for re-examination on Feb. 10, 1944, having no complaints. X-ray examination at this time was completely negative in respect to pulmonary disease.

**CASE 2:** *Direct Trauma to the Chest and Spontaneous Pneumothorax.* A white selectee, aged 26, appeared for induction on Feb. 15, 1944. On the way to the Station that morning, he got out of his car, slipped on the icy pavement, striking the xiphoid region of the chest against the door handle of the automobile. He was mildly dyspneic and slightly cyanotic but had no chest pain. A routine film showed 80 per cent collapse of the right lung with no evidence of rib fracture. The man's past history in general was negative and he had experienced no previous known spontaneous pneumothorax.

**CASE 3:** *Spontaneous Pneumothorax Not Following Undue Exertion, with Recurrences.* A white selectee gave a history of his first spontaneous pneumothorax at the age of twenty-five. This occurred while he was getting up from bed in the morning. A complete collapse on the right side was found at that time. He spent one month in a hospital and returned to work two months after the accident. One year later, a second pneumothorax developed on the same side, with pain in the chest and difficult breathing, as the patient was alighting from a car he had just been driving. A third attack occurred a year after that, and a fourth one, two years after the third, while the patient was sitting in his office. When he appeared for induction examination, a year after the last episode and six years after the initial pneumothorax, he was asymptomatic and x-ray examination showed normal lungs.

**CASE 4:** *Psychosomatic Complaints after Spontaneous Pneumothorax.* A white man, aged 20, was seen for a second induction examination on Feb. 26, 1944. Nine months before, at his first examination as a selectee, a left pneumothorax was discovered on the routine film. During the interval and on the second Station visit, he complained of annoying dull pain in the left chest and said he had been advised to take good care if he would avoid lung trouble. He expressed great anxiety lest he become a pulmonary invalid if he were accepted for military

service and could not be dissuaded from viewing the accident of spontaneous pneumothorax as a disabling disturbance, with dire forebodings.

**CASE 5: *Spontaneous Pneumothorax First Treated as Pleurisy.*** A white man, aged 33, was walking slowly on the grounds of the World's Fair, when he was seized with pain in the right chest. He went to a doctor three days later; a diagnosis of pleurisy was made and the chest was strapped. Having obtained little relief, the patient consulted another physician ten days after the attack. At this time an x-ray examination revealed 50 per cent collapse of the right lung. Four weeks later the patient returned to work. Three months passed, and he had a recurrence with 30 per cent collapse of the right lung, this episode also taking place while he was walking. This time he was absent from work only two and a half weeks. At the induction examination, four years after the last pneumothorax, the chest film was completely normal.

**CASE 6: *Spontaneous Hemopneumothorax, with Subsequent Changes in Lung Fields.*** A white selectee, aged 33, gave a negative history up to two years before induction. At that time, while eating breakfast, he was seized with an attack of severe respiratory distress requiring immediate hospitalization. At the hospital, examination revealed hemopneumothorax in the right chest with complete collapse of the lung. Bloody fluid was aspirated from the right thorax several times during a hospital stay of three weeks. The patient returned to work six months after this accident. A film taken at the Induction Station, two years later, showed thickening of the pleura on the right side, with marked retraction of the mediastinal structures to the right.

### CONCLUSIONS

1. A study was made of 100 unselected cases of spontaneous pneumothorax of the so-called idiopathic type, which had occurred in selectees for military service months to years before induction examination.

2. This condition occurs most commonly in the age group twenty to thirty years.

3. Spontaneous pneumothorax may appear asymptotically, as occurred in 5 per cent of this series. From its discovery

on routine chest roentgenograms, it may be assumed that this accident is more frequent than clinically supposed.

4. There is no notable predilection for one side of the chest rather than the other.

5. Recurrences take place in about 20 per cent of the cases, and on the same side. Recurrence was uncommon in men over thirty years of age.

6. Spontaneous pneumothorax occurred more often in this series during relatively slight physical exertion or with the patient at rest than following undue physical stress or strain.

7. Roentgenograms of the lungs taken months to years after re-expansion of the collapsed lung were negative in all but four instances. In the great majority of cases, one cannot tell from the film that a pneumothorax ever existed, nor could it be predicted from the film whether or not the patient would sustain a future recurrence. On the contrary, numerous cases of bullous emphysema seen at the Induction Station gave no history of spontaneous pneumothorax.

8. Many of the men were unduly apprehensive as to the possibility of future complications—recurrences and sequelae.

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# A Case of Arterial and Periarticular Calcinosis of Unknown Etiology<sup>1</sup>

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THE FOLLOWING case is one of unusual widespread arterial calcification associated with calcium deposits about the joints of the extremities.

A soldier attached to combat troops, age 24, with nineteen months' service in the Army, gave no antecedent history related to the present illness.

showed swelling about the joints of both hands. The swellings were not hot or tender, and there was no limitation of motion. The radial arteries at the wrist and the tibial arteries at the ankle were palpable, irregular, and hard. Blood pressure was 160/110, being the same in both arms. The thyroid was not palpable, but bilaterally in the submental region an irregular hard mass could be felt.

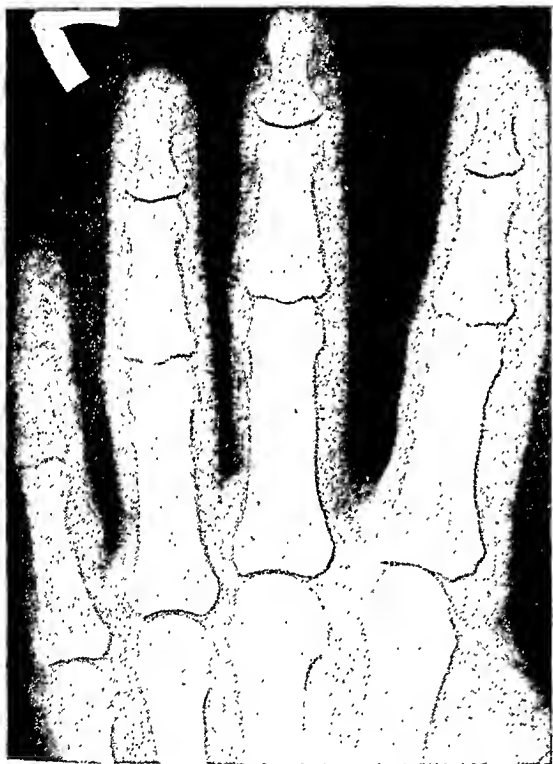


Fig. 1. Periarticular calcification of the interphalangeal joints of the hand.



Fig. 2. Pariarticular calcification of the interphalangeal joints of the foot.

Prior to service in the Army, he had worked in a nursery in the state of South Carolina. He was admitted to the hospital because of swelling, tenderness, and stiffness of the joints of both hands and stiffness of the right knee. These symptoms had come on gradually two weeks before admission.

The outstanding point of interest in the family history was that one brother had been discharged from the Coast Guard on account of "swollen joints." The patient's mother and father were both living and well, as were four sisters and two other brothers.

Physical examination on entry into the hospital

X-ray examination showed a most unusual picture. The hands (Fig. 1) and feet (Fig. 2) showed small calcium deposits about the interphalangeal joints; a small calcium deposit was seen about the elbow joint and calcium deposits were present in the subdeltoid bursae of both shoulders (Fig. 3). There were no complaints referable to the feet, elbows, or shoulders. Further films of the skeleton showed an extensive calcification of the middle-sized arteries. In the neck (Fig. 4) could be seen the common carotid artery, the superior thyroid, the lingual, and the internal carotid. The lingual artery was tortuous, dilated, and irregular, accounting for the palpable mass in the submental region. A chest film showed the heart to be normal in size and shape.

<sup>1</sup> Accepted for publication in July 1944.



Figs. 3 and 4. Calcification in the subdeltoid bursa and calcification of the common carotid, superior thyroid, lingual, and internal carotid arteries. The lingual artery is tortuous, widened, and palpable as a hard mass.

no calcifications in the thoracic aorta or in the pulmonary vessels. In the abdomen, the iliacs were partly calcified and there was extensive calcification of the renal arteries (Fig. 5) and of an aberrant renal artery on either side. Another calcified vessel (the inferior phrenic) (Fig. 6) was seen above the renal vessel on the left side. The abdominal aorta was not calcified except for that part which lies between the origin of the phrenic and renal vessels. The femoral artery (Fig. 7) was demonstrated bilaterally and could be followed to the popliteal and the division into the peroneal and posterior tibial. X-ray examination of the feet (Fig. 8)

demonstrated the anterior tibial, dorsalis pedis, and the first metatarsal dorsalis. In the forearm only a small part of the ulna artery showed calcification.

The x-ray appearance of all the bones of the extremities, spine, and skull was normal, with no suggestion of demineralization. It is to be noted that the calcification of the vessels was layed down not in streaks but in the form of irregular plaques. Furthermore, the vessels were elongated, and in some instances widened and tortuous.

Examination of the retina showed no sclerosis of the retinal arteries or vascular abnormalities.

To identify the calcified vessels as arteries rather than veins, a venogram was made following injection of 20 c.c. of 35 per cent diodrast into a small vein of the foot (lateralis marginalis), with a tourniquet applied high on the thigh. The films (Figs. 9 and 10) obtained showed the diodrast to be in the saphenous, popliteal, and femoral veins, and the calcifications to be in the arteries.

The diodrast also served the purpose of an intravenous pyelogram (Fig. 11). The kidney calices, pelves, and ureters were well outlined and of normal contour. The kidneys showed normal function, being well shown five minutes after injection. An interesting observation was the pressure deformity of the left kidney pelvis due to the renal artery, giving the so-called "derby hat deformity" sometimes found with an aberrant vessel (personal communication from Col. V. Mason).

Laboratory studies threw no light on the etiology or nature of the disease. The blood count was normal. The urine had a specific gravity of 1015, with a range of 1.008 to 1.028. No albumin, casts, or sugar were present. The Kahn test was negative. The blood chemistry was normal: non-protein nitrogen, 28 mg. per cent; creatinine, 1.2 mg. per cent; uric acid, 3.6 mg. per cent; cholesterol, 159 mg. per cent; serum phosphatase, 3.5 Bodansky units; serum calcium, 11 mg. per cent; serum phosphorus, 4.1 mg. per cent; glucose tolerance tests, fasting, 88 mg. per cent, 2d specimen, 137 mg. per cent, 3d specimen, 140 mg. per cent. The sedimentation rate was 3 mm. in one hour (Cutler).

A biopsy was performed, with removal of a small piece of the posterior tibial artery. The report by the pathologist, Major Cares, was as follows:

*"Gross:* Fresh section of artery 3 × 4 mm., which on palpation contains numerous calcium fragments. No definite lumen is seen grossly. On section, a fibrous substance interspersed with yellow, chalky granules is seen.

*"Microscopic* (Fig. 12): Some adventitial fat is adjacent to the thickened adventitia containing a number of recent nutrient vessels. Two small but definite plaques of calcium are located in the outer adventitial tissues. The bulk of the artery is composed of distorted, almost intermingled media and intima which are the seat of irregularly encapsulated calcium bodies. The muscular fibers of the media show incomplete replacement fibrosis and atrophy



Figs. 5 and 6. Fig. 5 (left) shows calcification of the renal and aberrant renal arteries on both sides. The renal arteries are widened and tortuous, and the calcium is laid down in plaques. Fig. 6 (right) shows calcification of renal arteries on both sides and the inferior phrenic artery on the left. The abdominal aorta is calcified on the left lateral wall. This represents the only calcification in the aorta.

over a large segment. The lumen is represented by a small channel lined by intermittent projecting clumps of calcium salts. The intima, as above mentioned, contains besides the calcium bodies an irregular, broad zone of granulation tissue and capillaries, with some scattered fibroblasts and histiocytes.

"The bizarre calcified patches contain amorphous, deeply acidophilic hyalin bodies or granules of variable size, which are generally imbedded in the plaque.

"An elastica van Gieson discloses incomplete destruction of the internal elastica, the residue showing splitting. There are only vestiges of an external elastica. The fibrosis demonstrable by the van Gieson is diffuse, involving even the sector of media seen in H. and E.

"A Gomori calcium stain emphasizes the spheroid nature of the calcium plaques, with the medial mass of amorphous tissue staining in mixed acidophilic and basophilic manner. No cell structures are discernible. In this particular section, the location of the calcium plaques is mainly intimal and medial, with a thin, fibrous, surrounding wall.

"*Diagnosis:* Diffuse arterial calcinosis (atypical Mönckeberg's sclerosis)."

The Army Institute of Pathology also reviewed the slides and could not add to the diagnosis. Their report is as follows: "We can add very little to your diagnosis. We thought that some of the calcification may have taken place in old thrombus material in the vessel lumen. There seem to be structures which suggest recanalized lumina."



Fig. 7A. Calcification of the femoral artery. See also Fig. 7B.

The patient showed no change in status during his stay in the hospital. The biopsy was without ill effects to the extremity. The joints remained stiff and painful, and transfer was made to a Veterans' Hospital for further care.

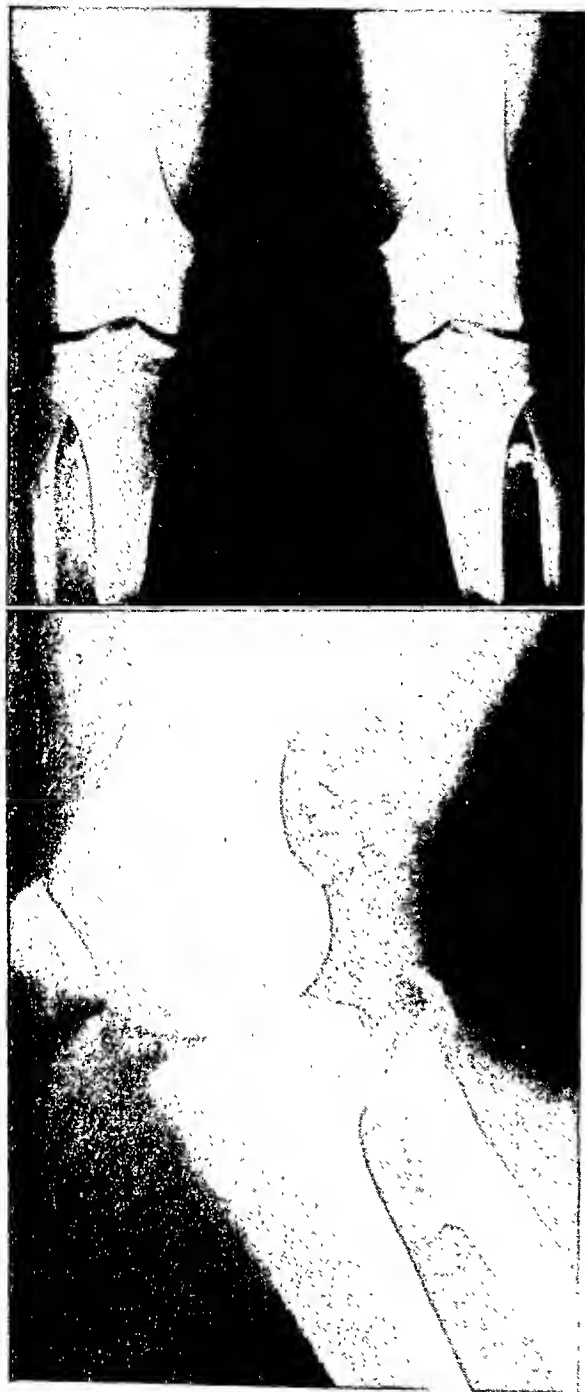


Fig. 7B. Calcification of the femoral artery, popliteal, peroneal, and posterior tibial. Observe the calcium laid down in plaques and the elongated vessels.

#### DISCUSSION

This patient presents an unusual picture of an extensive calcification of the medium-sized arteries. It is this type of artery in which the media is the predominating layer. The calcified vessels



Fig. 8. Calcification of anterior and posterior tibial arteries, the dorsal metatarsal, and the communicating arteries. A biopsy specimen was taken from the posterior tibial artery.

did not incapacitate him in any way. He had no vascular disturbance of the extremities. It was the joint deposits which brought him to seek medical attention, his complaints being stiffness and tenderness of the joints of the hand and stiffness in one knee. The blood pressure was high for a man of his age, as would be expected in view of the marked calcification of the renal vessels. However, there was no impairment in kidney function as demonstrated by intravenous pyelography or by the blood chemistry.

Considering the fact that the vessels involved were those with smooth muscle of the media predominating, one must first think of a Mönckeberg sclerosis (1). This type of sclerosis, described by Mönckeberg in 1903, seen in the fourth and fifth decades, consists of necrosis and massive calcification of the media with little or no change in the intima. It is most common in the lower extremities. It does not produce



Figs. 9 and 10. Venograms demonstrating saphenous, popliteal and femoral veins lying next to calcified artery.

vascular occlusion, as the calcification usually fixes the vessel in its largest diameter. It is not associated with a hypertension. The roentgen picture shows linear parallel (streaking) calcification. Against a diagnosis of Mönckeberg sclerosis in this case are the patient's age (there are no senile changes), hypertension, and the x-ray appearance, which shows the vessels to be widened, tortuous, and elongated, with irregular plaques. Biopsy also showed the calcification to be in all the layers.

Atherosclerosis is mentioned only to be excluded. This occurs in the larger and smaller vessels with well developed intima. It is just these vessels that were not involved. The large vessels, thoracic and abdominal aorta, were not affected except for the small patch in the abdominal aorta. The retinal arteries were normal. Enlargement of the left ventricle, frequently associated with atherosclerosis, was not present in this case.

A healed periarteritis cannot be considered, as this disease affects the small arteries, leaving the larger ones intact. Another point against this diagnosis is that



Fig. 11. Intravenous pyelogram made 10 minutes after injection of 20 c.c. of 35 per cent diodrast, demonstrating normally functioning kidneys, with normal contour. The left kidney pelvis shows a pressure deformity caused by the renal artery (so-called "derby-hat" deformity).

the patient had no history of any earlier illness with inflammatory lesions of the arteries.

None of the above-mentioned diseases would account for the calcium deposits about the joints.

Albright, Drake, and Sulkowitch (2) reported a case of renal osteitis fibrosa cystica. Their case and this one have many features in common, but their patient had, in addition to the calcinosis, a marked renal insufficiency and bone changes of osteitis fibrosa cystica. A similar complaint brought the patient to the hospital—painful swellings of the fingers of short duration. X-ray examination in each instance showed calcium deposits about normal joints. The vessels in their case also showed an extreme degree of medial calcification; in addition, there were changes in the retinal arteries, which were narrowed and sclerotic, and calcification in the arch and descending aorta. Their patient also had a hypertension. The





Fig. 12. Microscopic sections of posterior tibial artery. A. Gomori stain. Note relationship of irregular plaques (calcium salts stain black) to intima. The walls have undergone irregular fibrotic atrophy. Note calcium in the adventitia, the larger plaque showing calcium deposition in neutral fatty areolar tissue.  $\times 18$ .

B. Elastica van Gieson stain. The wall is partly disrupted. The arrow points to the remnants of the internal elastica. There are several recanalized areas in the intimal plaque. On the fringe are darker staining calcium masses.  $\times 16$ .

case differed from the one here presented in the severe degree of renal impairment.

The phenolsulfonphthalein test in Albright's case showed less than 5 per cent excretion in three specimens at fifteen, thirty, and sixty minutes. On intravenous pyelography, very little of the dye was excreted. The urine showed large amounts of albumin. The blood chemistry also showed abnormal changes: non-protein nitrogen, elevated, 120 mg. per cent; uric acid, 4.4 mg. per cent; blood sugar, 112 mg. per cent; fasting serum inorganic phosphorus level elevated to 9.8 mg. per cent; serum calcium level depressed to 8.2 mg. per cent; serum phosphatase elevated to 9.4 Bodansky units.

The case also differed from the one recorded here in that roentgenograms showed generalized decalcification of the skeleton and the skull had a thin moth-eaten appearance, characteristic of hyperparathyroidism. The absence of bone changes and lack of renal insufficiency precludes classification of our case in the group described by Albright *et al.* For the time being, the case will be designated as "extensive arterial calcification, etiology unknown, with calcium deposits about the small joints of the extremities."

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# Duodenal Obstruction Due to Tuberculous Lymphadenitis<sup>1</sup>

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IT IS WELL KNOWN that widening and varying degrees of compression of the duodenum may be caused not only by lesions occurring in the head or body of the pancreas but also by masses of enlarged regional lymph nodes (1-3). Widening of the duodenal curve has been seen as a result of metastatic carcinoma, lymphosarcoma, Hodgkin's disease, tuberculosis, and infectious mononucleosis (5 and 6). In the case to be described, severe constriction and partial obstruction of the duodenum were observed with relatively little widening of the duodenal curve. This finding has not been reported previously in connection with tuberculous lymphadenitis.

## CASE REPORT

E. S., a 23-year-old colored youth, was first seen at The Mount Sinai Hospital (Medical Clinic, OPD) in April 1942, complaining of anorexia, postprandial epigastric pain, vomiting, and progressive weight loss. His illness dated back about two years. In December 1940, he had entered Bellevue Hospital because of six months of anorexia, asthenia, low-grade fever, night sweats, bilateral pleuritic pain, and a non-productive cough. Here he was found to have a right pleural effusion, but there was no roentgen evidence of parenchymal tuberculosis, nor were acid-fast bacilli found in the sputum or gastric contents. Patch and Mantoux tests were negative. The patient, nevertheless, was considered to be suffering from pulmonary tuberculosis and was transferred to Triborough Hospital, where he was placed at bed rest for six months, during which time the effusion resolved. Here, too, attempts to prove a tuberculous etiology were unsuccessful. After the resorption of the fluid, however, questionable enlargement of the hilar nodes was observed roentgenographically. A low-grade fever was still present on discharge.

Almost immediately following his departure from the hospital, on July 19, 1941, the patient began to experience sharp, cramp-like epigastric pain, appearing two or three hours following meals, non-radiating and relieved by alkalies and vomiting. He became progressively weaker, lost about 15 pounds, and continued to run a low-grade fever.

In April 1942, he was seen at the Medical Clinic of The Mount Sinai Hospital. A gastro-intestinal series at this time revealed a 50 per cent retention after six hours and a constricting lesion involving the pylorus, duodenal bulb, and proximal part of the second portion of the duodenum. These findings were so unusual for a youth of his age that the patient was asked to return for a second examination. In the meantime he was placed on a Sippy diet. He failed to reappear and neglected to follow the diet prescribed.

One year later the patient returned to the clinic because of progression of symptoms. Vomiting was now the chief complaint, beginning about one hour after a meal. The gastro-intestinal series was repeated (Figs. 1 and 2). Retention at the end of six hours was now 75 per cent; constriction of the second portion of the duodenum was increased, and there was slight constriction at the duodenojejunal angle. There was evidence of stasis in the lower part of the second portion of the duodenum and upper part of the third portion. A pressure deformity on the greater curvature side of the antrum and a slight widening of the duodenum were also present (Fig. 1). Because of these findings, the patient was referred to the hospital for study.

He was emaciated and appeared chronically ill. Physical examination revealed no unusual findings in the heart, lungs, or abdomen, and no lymphadenopathy. The temperature was 101° F. Blood examinations showed a hemoglobin of 55 per cent and white cells numbering 5,350 with a normal differential count. The sedimentation time was eighteen minutes compared with a normal of sixty minutes. A guaiac test of the stools for occult blood was negative. Patch and Mantoux (1-1,000 O.T.) tests were also negative, and the gastric contents and sputum failed to show acid-fast bacilli. Urinalysis, electrocardiography, and roentgen examination of the chest and abdomen showed nothing unusual. A Rehfuess test meal revealed normal acidity, and gastric aspiration showed a considerable six-hour residue. A third gastro-intestinal series again revealed the abnormalities previously seen, and the report was: "duodenal obstruction due to a retroperitoneal process in the region of the head of the pancreas."

From the onset, the diagnosis of peptic ulcer was discarded because of the history and the roentgen changes. Three possibilities were entertained: tuberculous lymphadenitis, abdominal lymphoma (Hodgkin's or lymphosarcoma), and carcinoma of the head of the pancreas. The roentgen appearance

<sup>1</sup> From the Department of Radiology and the Department of Surgery of The Mount Sinai Hospital, New York, N. Y. Accepted for publication in August 1944.



Fig. 1 (left). Marked constriction of the second portion of the duodenum and slight constriction of the duodenal-jejunal angle. A pressure deformity is seen on the greater curvature side of the antrum with considerable deformity of the duodenal bulb.

Fig. 2 (right). Retention of barium (75 per cent) at the end of six hours.

was compatible with a malignant neoplasm in the head of the pancreas, but the very slow progression of the lesion under observation, as well as the continued absence of jaundice in the presence of such marked structural deformity, made such a diagnosis unlikely. Hodgkin's disease and lymphosarcoma could not be excluded. Certainly the history of pleural effusion in a Negro suggested a tuberculous infection. Abdominal tuberculous lymphadenitis was considered as the tentative diagnosis. The absence of calcification and of tuberculin sensitivity was not felt to militate against this opinion.

Surgery was undertaken to relieve the obstruction, to improve nutrition, and to establish the diagnosis. At operation numerous fine adhesions were seen in the region of the liver and the duodenum. The entire retroperitoneum was boggy and edematous. In the gastrohepatic and gastrocolic ligaments, as well as beaded along the duodenum, were soft, greatly enlarged lymph nodes. The severe inflammatory reaction undoubtedly contributed greatly to the constriction observed in the second portion of the duodenum. The antrum of the stomach was thickened and edematous. A gastro-enterostomy was performed and a lymph node was removed for study. The pathological report was hyperplastic tuberculosis with no caseation. No acid-fast bacilli were found. Following an uneventful postoperative course, the patient was dis-

charged, still febrile but without gastro-intestinal symptoms. He was sent to Seaview Hospital, where a protracted convalescence was planned.

#### DISCUSSION

This case is of interest in the first place, because it represents a type of tuberculous disease uncommon today; in the second place, it presents a pathological process, the roentgen appearance of which may be confused with that of carcinoma of the head of the pancreas.

Prior to the Great War, the incidence of tuberculous infection of the mesenteric and retroperitoneal lymph nodes was rather high. It has been reported that involvement of these nodes was seen postmortem in 50 per cent of children dying of or with tuberculosis in 1918. The diminished incidence in this country, to the point of rarity, has never been fully explained. It parallels the disappearance of cervical tuberculosis. Opie (7) believes it to be a result of eradication of bovine tuberculosis through sanitation and pasteurization.

Abdominal lymphatic tuberculosis is a protean affliction, recognition of which depends upon a history of tuberculous infection, the presence of symptoms of systemic tuberculosis, and objective x-ray and laboratory evidence. Calcification demonstrated roentgenographically is helpful, but unfortunately this is seen in only about 40 per cent of the cases. Tuberculin sensitivity rarely is of assistance in differential diagnosis because it is usually minimal or absent. Symptoms are usually due to the pressure of matted nodes or bands of adhesions constricting an abdominal viscus. Cases have been reported in which there was confusion with acute appendicitis, renal calculus, cholecystic disease, peptic ulcer, and intestinal obstruction. The cases of obstruction hitherto reported have been chiefly in the ileum, occasionally in the jejunum.

Except for conditions such as foreign bodies, calcification, etc., which are seen upon the ordinary x-ray film, the roentgen diagnosis of disease of the pancreas depends almost entirely on the presence of a pressure defect in the barium-filled stomach, duodenum, or transverse colon. It is well recognized that a sufficient enlargement of the head of the pancreas or the regional nodes, if near enough to the barium-filled bowel, will produce some evidence of pressure, such as widening of the duodenum, diminished caliber of its lumen, changes in the direction or destruction of the mucosal folds (8).

From the foregoing description it can readily be seen that many types of masses in the region of the head of the pancreas may produce similar defects and that differential diagnosis at times is difficult or even impossible. There are, however, a

few helpful criteria. Many authors feel that if there is marked irregularity of the mucosa of the second portion of the duodenum, the diagnosis of carcinomatous infiltration can definitely be made. It is of interest, therefore, that this case presented all the usual criteria associated with carcinoma, namely, constriction and destruction of the second portion of the duodenum and little widening.

#### CONCLUSIONS

1. An unusual case of duodenal obstruction due to tuberculous lymphadenitis is presented.

2. The usual criteria for diagnosis of carcinoma of the head of the pancreas may be produced, also, by inflammatory nodes in this region.

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# Jejunal Intussusception through a Gastro-Enterostomy Stoma<sup>1</sup>

FRANK E. BUTLER, M.D., IVAN M. WOOLLEY, M.D., and WM. Y. BURTON, M.D.

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**I**NTUSSUSCEPTION through a gastro-enterostomy stoma has been reported many times in the literature of surgery, but we find little reference to this condition in roentgenological literature. The symptoms in the following case correspond well with those presented in the several case reports that have come to our attention.

W. B., aged 47, male, was referred to our office by Dr. M. E. Steinberg for gastro-intestinal x-ray examination, April 20, 1943. He complained of intermittent attacks of pain in the left epigastrium occurring periodically since performance of a gastro-enterostomy in 1931. He had previously had an operation for a perforated gastric ulcer in 1930. At times the pain was relieved by food. There was no history of gastric hemorrhage or blood in the stool. X-ray examination was reported as follows:

"A barium meal was given and the esophagus was normal. The barium entered the stomach in the normal fashion and passed readily to the pars media. At this point the barium divided into two streams and it was thought at first that the lower stream represented barium leaving the stomach by way of the gastro-enterostomy stoma. However, a few inches beyond the point of deviation the two streams met again and joined into one column in the antral portion of the stomach, leaving a large irregular 'island' defect in the gastric lumen which was free of barium. The stomach was freely mobile and no mass could be felt, but the patient was extremely tender to pressure over the defect.

"The barium began to leave by way of the pylorus and the first portion of the duodenum. The cap showed some deformity but no gross defects could be seen.

"As more of the meal was taken, the barium took the same course as above described until the defect became obliterated by the overlying barium. When the stomach was filled, the defect could be demonstrated by pressure over the area. At no time during the examination was any barium seen to leave the stomach via the gastro-enterostomy stoma.

"Serial radiographs failed to reveal the defect but showed evidence of irregularity and considerable irritability of the pyloric antrum and the cap. There was no evidence of barium escape through the stoma.

"*Impression:* There is an encroachment upon the gastric lumen, either by a hyperplastic mass on the

posterior wall of the stomach which occludes the stoma or a defect caused by extrinsic pressure of some adjacent structure, such as the pancreas. This examination should be repeated for further study of the stomach. A gastroscopic examination would be of considerable value in obtaining further information."

The patient was admitted to the Emanuel Hospital May 1, 1943, with the following history.

"This patient was operated upon for a perforated gastric ulcer in 1930. A gastro-enterostomy was done in 1931. Since this last operation the patient has had a continuous pain in the upper left side of the abdomen, increasing in intensity during the last few years. At times the pain was relieved by food; at other times taking of food made it worse. Six weeks prior to his admission to this hospital, while at stool he experienced an intense pain and feeling of distention in the lower left side of the abdomen. Upon clutching his left side he felt a rounded mass 'about the size of a hand-ball.' He passed another loose stool and then a third stool within the hour. During this defecation the pain was so intense that he fainted. When the physician arrived about one hour later, the patient was free of pain or distress and the abdominal tumor had disappeared."

At operation, May 6, 1943, by Dr. M. E. Steinberg, adhesions were found between the omentum and the anterior peritoneal wall. The gallbladder was adherent to the duodenum. The pyloric end of the stomach felt thickened and irregular. The gastro-enterostomy was on the posterior wall of the stomach. Approximately 10 cm. of the distal jejunal loop was found to be invaginated into the stomach (retrograde invagination of the jejunum). The jejunal loop was pulled out of the stomach, but it immediately invaginated upon itself and entered through the stoma again. Approximately three-fourths of the stomach, including the thickened area of the pylorus and a part of the duodenum, were resected. A retrocolic gastrojejunal anastomosis was accomplished according to the Finsterer technic of the Billroth II method. The old opening in the jejunum was utilized for the anastomosis.

After the stomach was opened the pyloric opening was found to be very narrow and there were several radiating scars on the lesser curvature border of the antrum near the pylorus. There was also a flattened serpiginous area of ulceration about 2.5 cm. in diameter along the mid-portion of the lesser curvature.

The patient made a good recovery

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<sup>1</sup> Accepted for publication in April 1944.

# EDITORIAL

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## American Medicine Tomorrow<sup>1</sup>

In his excellent book comparing the theories of Oswald Spengler and Raymond Pearl, *Today and Destiny*, Edwin F. Dakin expresses a truism that is of particular significance for doctors in these dynamic times: "Any concept—economic, political, or cultural—which leaves its possessor wholly unprepared for tomorrow is of doubtful validity. Conversely, men who are not surprised when the future comes, lie very close to the truth."

President Lowell S. Goin was pleading for a true concept of the future when, in a recent letter to Members and Fellows of the American College of Radiology, he warned of impending social changes that would almost certainly result in new methods of distribution for medical services. He urged radiologists to actively encourage voluntary prepayment plans for medical care, sponsored by medical societies, as the soundest and most desirable method among the many that have been proposed. At the same time, he warned that some form of socialized medicine, embodying compulsory health insurance, is not an inconceivable eventuality.

Doctor Goin's concern would seem to be justified by what most observers have recognized as an increasing pressure of public opinion. The attitude of the public was succinctly expressed by *Fortune* magazine in its December issue: "The state of medicine in the United States is a social problem because the country's conscience has made it so . . . people who cannot find or pay for proper medical care are resentful."

I have been sharply criticized in some quarters for a statement made in my

Annual Report to the Board of Chancellors two years ago, in which I referred to the powerful social forces at work throughout the world and their manifestation in agitation for socialized medicine in this country. I remarked that there was a growing conviction among medical men that a head-on opposition to this unmistakable trend would be as unwise as it would be futile. Subsequent events have proved, I believe, that the demands for improvements in the distribution of medical services must be met, either by voluntary plans for prepayment or, if not, then by compulsory health insurance. It seems unnecessary to recite the extensive evidence that this is so. A half dozen public opinion surveys have revealed a definite public demand for insurance against medical costs.

Brigadier General Fred W. Rankin, in his presidential address before the American Medical Association House of Delegates last year, called upon the medical profession to recognize the gathering momentum of trends that are "directed toward some form of national health service as an integral function of the state." He made a plea that they be regarded not in the light of apostasy, but rather in the light of realism.

Dr. Alan Gregg, whose words carry considerable weight in the medical world, has uttered a similar warning. "The danger for medicine in America lies in failure to acknowledge and to study the sociologic aspects of medicine—the social matrix. We are loath to see that research and teaching, as well as the practice of medicine, will change when change comes in the prevalent interpretations of the role

<sup>1</sup> Presented as the Annual Report of the Executive Secretary to the Board of Chancellors of the American College of Radiology, Chicago, Ill., Feb. 8, 1945. Published in part in certain state journals.

of government and the structure of our society," he says.

It would appear, therefore, that if we are not to be unprepared for tomorrow, we should give consideration in our deliberations to the likely effects of all the various proposals for changes in the economics of medicine.

In our efforts to peer into the future of medical practice in the United States, I think we should keep one very important point clearly in mind. It is this: Every system of compulsory health insurance in all the countries of the world has been built upon existing agencies for the distribution of medical care. On the basis of history, therefore, we can assume that, if a system of compulsory health insurance is adopted by Federal or State governments in this country, existing plans for the application of the insurance principle to payment for medical care will be utilized by the state. The obvious corollary is that medical practitioners would carry on under the state plan much as they did under the voluntary plans which preceded it. This has been the almost universal experience in European systems.

Writing on the "Origins of Health Insurance," in their excellent book on that subject, Simons and Sinai show that compulsory health insurance is built out of three existing institutions: insurance or prepayment plans, the state, and the medical profession. "The relations, reactions, and relative strength of these determine much of the character and results of the operation of existing insurance systems," they say. Their study of compulsory health insurance throughout the world leads them to conclude that pre-existent voluntary prepayment plans have dominated the state systems which followed.

Douglas and Jean Orr, in their book on the British experience with health insurance, point out that the form which the national health system of England finally took was determined by the "Friendly Societies" which had existed for many years as voluntary plans for prepayment to meet the costs of sickness.

Sir William Beveridge, in his epoch-making report on social insurance in England, observes the part which the voluntary plans have played in setting the pattern of the government system. He contemplates, though with frank displeasure, that they will continue to be utilized as distributing agencies in the expanded system which will undoubtedly be adopted in Great Britain. He implies, incidentally, as have others before him, that voluntary sickness insurance promotes, rather than deters, the adoption of compulsory systems. In 1909, David Lloyd George pointed to the "Friendly Societies," which were comparable to our present prepayment plans, as proof of the feasibility and desirability of compulsory sickness insurance. The National Health Insurance Act came three years later. It is significant, perhaps, that efforts to enact compulsory insurance laws in our own country are today most concentrated in the two states with the oldest and largest voluntary medical service plans, California and Michigan.

We all hope that voluntary prepayment plans, sponsored either by medical societies or commercial insurance carriers, will meet the palpable demand of the public for relief from the unpredictable financial burdens of illness. If they do not, the lessons of history teach us that organized medicine has yet another compelling reason for extending these plans as rapidly and as widely as possible. Once firmly established, they would set the pattern and determine the methods to be followed in the event a compulsory system is adopted.

This is a matter of the very greatest importance for the doctors of America. It is surely unnecessary to remark, for instance, that the future of radiology will largely be determined by its status in voluntary prepayment plans, whether or not these plans are later superseded by a compulsory system.

Now, in the light of these considerations, the group hospitalization movement, concerning which organized medicine has been exceedingly circumspect, acquires a new importance that tends to justify medicine's



diffidence. Are the Blue Cross plans to duplicate the history of England's Friendly Societies? Two facts lend credence to an assumption that this is altogether possible.

First, a determined effort is being made by directors of Blue Cross plans to extend their benefits to include complete surgical or medical care. Second, Blue Cross plans would almost certainly be preserved and integrated in a compulsory sickness insurance plan.

The first of these statements will be promptly denied by Blue Cross leaders. But the facts speak for themselves. In Delaware, the Blue Cross plan has already been expanded to include cash benefits for surgical care. It is administered by a Board of Trustees on which there are two hospital representatives for every doctor. Also, in West Virginia and North Carolina, hospital service plans have assumed full control of medical care plans.

The American Hospital Association, at its recent annual meeting, considered recommendations from several speakers for "extending prepaid hospital plans to cover outpatient care." At the same meeting the Hospital Service Plan Commission approved a proposed model enabling act for comprehensive health service plans which would require, among other things, that any plan incorporated under the act be controlled by a board composed of one-third hospital trustees, one-third doctors, and one-third lay representatives of the public. In the course of the discussions, Mr. Louis H. Pink, president of Associated Hospital Service of New York City, urged expansion of Blue Cross to include the costs of medical care without delay.

In Philadelphia, where the medical society several years ago fought a bitter and unsuccessful battle to exclude radiology and pathology from the hospital service plan, a proposal has very recently been submitted to add complete medical care to Blue Cross benefits. The proponents candidly recommend repeal of the present Pennsylvania enabling act, which requires that a majority of the directors of medical service corporations be doctors of medicine.

Now I desire that I not be misunderstood. Coöperation between hospital service plans and medical or surgical service plans is essential. It is rather generally agreed among hospital leaders that Blue Cross enrollment has about reached its maximum unless contracts for hospital service can be coupled with insurance against medical costs. There is no doubt that the United States Public Health Service will emphasize this fact in the report of a study it is currently making of the movement. Furthermore, it is both logical and economical to delegate responsibility for sale and routine administration of the medical service plan to existing Blue Cross plans which have several years of experience and have acquired trained personnel. But, medical societies which turn over complete control of prepaid medical care to Blue Cross plans that are controlled by hospitals are traveling a dangerous road. They are violating one of the basic principles of organized medicine if they fail to establish a separate corporation to control the medical plan, with a board of directors of which at least a majority are doctors.

Ten years ago the American Medical Association laid down the postulate that: "All features of medical service in any method of medical practice should be under the control of the medical profession. No other body or individual is legally or educationally equipped to exercise such control." This principle has lost none of its validity.

If anyone is inclined to minimize the importance of this principle, he has but to follow the course of the controversy that has persisted between hospital service plans and the organized medical profession over the inclusion of certain medical services as a part of hospital care. For ten long years, county, state, and national medical organizations have insistently demanded that radiology and pathology be excluded from Blue Cross benefits. Everyone knows that the reaction of hospitals to these unequivocal demands has been one of polite indifference. What makes anyone think they

would follow the dictates of the medical profession concerning other branches of medicine, once they were in control of medical service plans?

Constantly during recent years the American College of Radiology has warned that medicine would sacrifice a basic principle if it yielded to the adamant demand of hospitals that they be permitted to include radiology and pathology in Blue Cross benefits as a part of hospital care. Too often our admonition that this would open the door to further encroachments by which hospitals would assume added prerogatives in the delivery of medical services, has fallen on unheeding ears. Now, as one medical editor has sardonically remarked, "The beans are on the carpet, spread out for all to see."

The second fact stated above, that Blue Cross plans would be integrated in a system of compulsory insurance, is likewise more than a mere assumption. Witness the curious tergiversation that has taken place in Rhode Island. Not long ago the governor of Rhode Island proposed a law for compulsory hospitalization insurance in his state. Promptly Blue Cross executives all over the country assailed the proposal as "un-American" and "regimentation." But, when the governor publicly announced that he contemplated the use of Blue Cross as an agency under the system, opposition quietly died.

The Wagner-Murray-Dingell bill, as you know, authorizes the Surgeon General to "negotiate agreements . . . with private agencies or institutions . . . to utilize their services and facilities. . . ." In response to a question from hospital spokesmen, Surgeon General Parran has already expressed the view that this would include Blue Cross plans.

I would point out that this provision in the bill would also permit medical service plans operated by medical societies to enter into contracts for rendering services to beneficiaries. Significant, also, is the provision in the Wagner bill which permits the practitioners in each area to elect the method by which payment shall be made

for services. Does this not offer sufficient reason for medical societies to set up their own plans for prepaid medical care?

Unfortunately for radiologists, all the current problems confronting the private practice of medicine are egregiously manifest in the case of radiology. The threat of compulsory health insurance offers no exception. The future progress and advancement of the science of radiology may very well be determined by the status this specialty is accorded in voluntary plans for prepayment. Thus, the long unhappy fight of the American College of Radiology against the inclusion of medical services as a part of hospital care in group hospitalization assumes added significance.

It is encouraging to note that considerable progress has been made in solving this controversy. In Washington and Iowa, for instance, Blue Cross has agreed to separate radiology from hospital care and to pay cash benefits to the physician for x-ray services. The next step is to transfer these medical benefits from the hospital service plan to the medical service plan, where they belong. This has already been agreed to in New York, where, incidentally, the battle between radiologists and the hospital service plan has been hottest. Last year the Hospital Association of New York State approved a resolution providing that, "in those counties or areas where a Blue Shield Medical Care Plan exists, all prepaid medical and surgical care provided for under any prepaid plan and given through the hospitals or outside of the hospitals should be covered under the Blue Shield Medical Care Plan." The hospital association agreed that when medical service plans were established in areas where they do not now exist, the Blue Cross plan in the community would drop radiology, pathology, anesthesiology, and physiotherapy from its benefits and allow these services to be covered like other medical specialties in the medical service plan. We should offer our commendation to the New York Hospital Association for this splendid step toward solution of a controversy that has unfortunately caused ill

feeling on all sides and has undoubtedly retarded the growth of the Blue Cross movement.

Now, then, we have added incentive to continue our endeavors to place radiology on an equal footing with other medical specialties in all plans for prepaid health service. In voluntary plans, the services of a radiologist should be provided like other consultant's services among medical benefits. They should never be included in the per diem paid to hospitals for hospital care. Furthermore, with due respect for the many excellent features of the Blue Cross movement, I think we have every reason to raise our voice in opposition to those who would allow the hospital service plans to adopt the role of England's Friendly Societies by assuming control of medical care plans. There is a place for both, operating in close coöperation but each autonomous in its own field.

Although some of the proposals for compulsory health insurance submitted to Congress in recent years have included radiology among the services to be furnished by hospitals for a specified per diem, the Wagner-Murray-Dingell bill provides for separate payment to radiologists. It would be unfortunate if Blue Cross were to establish a different precedent. I believe we are justified in doubting that Blue Cross plans would separate radiology from hospital care if they were permitted to extend their benefits to cover medical or surgical services.

I have attempted here to present a point of view which I think carries profound consideration for American medicine, and especially for radiology. I have not said that voluntary plans of sickness insurance will be superseded by a compulsory system. I honestly do not believe they will be. But, as my friend A. M. Simons has wisely said, social experiments invariably establish patterns of precedent that are seldom completely reversed. In these dynamic times we have extra reason to be vigilant and to exercise sound judgment in our decisions.

Fortunately for the radiologists of Amer-

ica an instrument for maintaining vigilance and directing policies on the basis of sound interpretation exists through the American College of Radiology. It provides what former president W. Edward Chamberlain has referred to as "fire-fighting machinery." Even if the fires cannot always be extinguished, the program of the College keeps them under control and helps to guide the course of future events in a direction least harmful to accepted principles of good radiologic practice.

The magazine, *Medical Economics*, in a recent article, referred with approval to the aggressive program of the College and observed that it was leading the spearhead of medicine's fight against the tendency for third-party agencies to assume the role of distributing agencies for medical services. Said *Medical Economics*: "While the other clinical specialists have a large stake in any such dispute, the radiologists are taking the lead through their vigorous organization, the American College of Radiology."

The reports of the various Commissions and Committees of the Board of Chancellors to be presented at this meeting offer good evidence of the fact that the College is alert, informed, and active, and that it has a positive program for the preservation of essential principles. This program, of course, is not confined solely to socio-economics. The broad scope of the College program in education, hospital standards, and other activities of the organization are directed toward a single objective: the advancement of the science of radiology and the promotion of its contributions to human welfare.

I am constrained to say again, as I have before, that the Members and Fellows of the American College of Radiology should be grateful to their appointed leaders, who direct the affairs of the College, for the unselfish effort these individuals are devoting to a cause which they approach with the deepest sincerity.

MAC F. CAHAL

*Executive Secretary*

*American College of Radiology*

## RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

At a recent meeting of the Radiological Section of the Los Angeles County (California) Medical Association, the following were elected officers for the current year: Donald R. Laing, M.D., President; Herbert A. Judson, M.D., Vice-President; Roy W. Johnson, M.D., Secretary; Henry Snure, M.D., Treasurer.

## SOCIEDAD PERUANA DE RADIOLOGIA

The Radiological Society of Peru, founded in November 1938, announces the following list of officers for the present year: President, Dr. Enrique Gonzáles Vera; Vice-President, Dr. Lorenzo Horna Gil; Secretary, Dr. Victor Giannoni; Pro-Secretary, Dr. Julio Bedoya Paredes; Treasurer, Dr. Santiago Sánchez Checa; Librarian, Dr. Francisco Guerrero Burga.

## In Memoriam

### JOHN MILTON HILL

1898-1944

Dr. John Milton Hill died on Nov. 13, 1944, in the Walter Reed Hospital, following an operation for a brain tumor. Doctor Hill was graduated from the University of Pittsburgh School of Medicine in 1932. He served on the staff of the Passavant, St. John's General, Presbyterian, and Woman's Hospital, Pittsburgh, and was assistant radiologist at the Falk Clinic. He was commissioned a major in the medical reserve corps of the U. S. Army in 1942, was subsequently promoted to lieutenant colonel, and served in Australia. Doctor Hill was a diplomate of the American Board of Radiology and a member of the American College of Radiology and the Radiological Society of North America.

### HARLAN PAGE MILLS, M.D.

1873-1945

Dr. Harlan Page Mills, of Phoenix, Ariz., for many years Counsellor of the Radiological Society of North America for Arizona, died at the age of seventy-two on Feb. 27, 1945.

Doctor Mills was born in Isadora, Mo., received his medical degree from the Marion Sims-Beaumont Medical College, known later as the St. Louis University School of Medicine, and spent some years in general practice in that state. In 1914 he joined the staff of the Arizona State Hospital at Phoenix. In 1917 he was induced to become associated with the Pathological Laboratory, then a young and struggling venture in the medical life

of the state. His work in that organization and in St. Joseph Hospital and the Good Samaritan Hospital, Phoenix, occupied the remainder of his professional life. He served as head of the department of pathology and later as consulting pathologist in each of these hospitals. While Doctor Mills' primary interest was in pathology, he was almost equally well known as a radiologist. Among his contributions to the literature are a number, in collaboration with Dr. Wm. W. Watkins, appearing in *RADIOLOGY*. He was a member of the Southwestern Medical Association, a Fellow of the American College of Physicians, and a diplomate of the American Board of Pathology.

### FRANK C. NEAL, M.D.

1879-1945

Dr. Frank C. Neal, of Peterborough, Ontario, died suddenly on Jan. 18, 1945, while examining a patient. Doctor Neal was a graduate of Toronto University and studied also in England. He had been in practice in Peterborough for forty years. He was a Fellow of the American College of Physicians and a member of the Radiological Society of North America.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**MASS RADIOGRAPHY OF THE CHEST.** By HERMAN E. HILLEBOE, M.D., Medical Director, Chief, Tuberculosis Control Division, U. S. Public Health Service; Professorial Lecturer on Tuberculosis Control, George Washington University School of Medicine, Washington, D. C., and RUSSELL H. MORGAN, M.D., Surgeon (R), Medical Officer-in-Charge, Radiology Section, Tuberculosis Control Division, U. S. Public Health Service; Assistant Professor of Roentgenology (absent on leave), The University of Chicago. A volume of 288 pages, with 93 illustrations. Published by the Year Book Publishers, Inc., Chicago, Ill. Price \$3.50.

**RADIOLOGIC EXAMINATION OF THE SMALL INTESTINE.** By ROSS GOLDEN, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director of the Radiological Service, The Presbyterian Hospital, New York. A volume of 239 pages, with illustrations of 183 subjects in 75 figures. Published by J. B. Lippincott Co., Philadelphia. Price \$6.00.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer, Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Oehsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*St. Louis Society of Radiologists.*—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 p.m. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 p.m., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 p.m., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison 6, Wis. Meets every Thursday from 4 to 5 p.m., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

**Stereoscopic versus Plain Films in Accessory Sinus Examinations.** Frederick M. Law. *Ann. Otol., Rhin. & Laryng.* 53: 531-535, September 1944.

For roentgenography of the accessory nasal sinuses, stereoscopic films are generally most satisfactory. They are particularly indicated under the following conditions:

- (1) Fractures of the skull.
- (2) Fractures of the nasal bones. Here they enable one to see which side is fractured and how much displacement exists.
- (3) Where a film taken in the Waters position shows an apparent tumor in the antrum. The stereoscopic view may show the suspected tumor to be merely the image of the cheek or upper lip superimposed on the antrum.

- (4) Where the film taken in the Waters position is negative while one taken in the 23°-angle position is positive. The stereoscopic film may show the opacity in the latter view to be due to an increased density of the floor of the posterior cranial fossa.

- (5) Where it is difficult to determine whether the right or left ethmoid shows a change in the appearance of the cell structure as viewed on the lateral film.

- (6) Where it is difficult to determine on which side a large agger cell exists.

- (7 and 8) Where an enlargement of the sella turcica or bony involvement of the skull is present.

- (9) When absence or four-plus involvement of a frontal sinus is suggested by a faint circular line of density where the superior border of the frontal sinus should be. A stereoscopic film may show this line to be part of the occipital suture superimposed on the frontal region, and not the superior border of the frontal sinus, thus proving the absence of the latter.

- (10) Where the lateral film shows an apparent partition dividing the antrum into two sections. A stereoscopic film will show this apparent partition to be the posterior border of the malar bone.

- (11 and 12) For examination of the petrous pyramid and for salivary calculus.

- (13) Where an apparent soft-tissue tumor is shown on lateral films of the pharynx. A stereoscopic film may identify this as the lobe of the ear.

- (14) In the presence of a malignant neoplasm involving the antra. The stereoscopic view reveals more accurately the degree of bony involvement.

STEPHEN N. TAGER, M.D.

**An Otolaryngologic Aspect of Frontal Meningocele.** Report of Cases. E. A. Stuart. *Arch. Otolaryng.* 40: 171-174, September 1944.

Frontal meningocele is rarely encountered, but it must be considered in the differential diagnosis of various fronto-orbital conditions. It is usually congenital in origin and therefore precedes any development of the frontal sinuses. It may, however, be the result of trauma, as in one of the four cases presented here. For this reason, it is impossible to rule out a diagnosis of frontal meningocele simply because the lesion has appeared after birth.

In each of the cases in this series treatment was sought during the first year of life. A patient with a

small meningocele who did not seek medical advice until adolescence or adult life would present a greater diagnostic problem.

Roentgenograms in the case of a boy of eleven months are reproduced. They show a frontal meningocele associated with separation of the orbits and defective development of the cribriform plate and portions of the superior orbital plates.

**Oral Aspect of Cleidocranial Dysostosis.** William S. Britt. *Mil. Surgeon* 95: 143-147, August 1944.

The author discusses the salient features of cleidocranial dysostosis, with special emphasis on the oral aspect, and reports a case. These patients are generally small. The head is large and brachycephalic, with sutures and fontanelles showing delayed closure; there is characteristic bossing of the frontal, parietal, and occipital bones, with prominent median groove or furrow. One or both clavicles may be absent. The jaws are slightly undersized, the maxilla being micrognathous and the mandible prognathous. The maxilla is narrow and shows lack of development, with a high palate and overcrowding of the teeth. The most outstanding dental anomaly is the extreme delay in dentition and eruption of the teeth. X-ray examination in most cases shows a large percentage of the permanent teeth unerupted. Teeth not having predecessors, such as the first and second molars, are often seen in normal erupted positions. Extensive caries, periodontoclasia, and gingivitis are common because of the abnormal occlusion of the teeth and consequent lack of natural exercise of teeth and gums.

### THE CHEST

**Mass Chest Roentgenography and Admissions to Olive View Sanatorium.** Joseph Goorvitch. *Am. Rev. Tuberc.* 50: 214-222, September 1944.

For the purposes of this study, the literature on mass roentgenography of the chest was reviewed, including data on more than 800,000 examinations. The consensus of opinion among those who have had experience with such a procedure is that minimal and often more advanced stages of pulmonary tuberculosis, among other abnormalities, can be discovered only by roentgenography.

The effect of routine induction and isolated pre-employment chest roentgenography in the county of Los Angeles on the admissions to Olive View Sanatorium is analyzed. It was found that such mass examinations have led to both a relative and an absolute increase in the number of males admitted, reversing the pre-war ratio of males to females. There was, however, no change in incidence of far advanced disease among all males admitted, in spite of the fact that in 23 per cent of them the disease had been discovered during routine surveys. Several explanations are offered: Pulmonary tuberculosis, when first diagnosed, is more advanced in males than in females, according to reports in the literature. The extent of involvement in cases discovered in mass surveys was decidedly less than among males admitted following diagnosis by non-survey methods. Those with advanced disease are more likely to seek and gain admission to a sanatorium.

L. W. PAUL, M.D.

**Case Finding by Mass Radiography. A Report on 500 Selected Cases.** Alexander Kahan and H. G. Close. *Lancet* 1: 653-654, May 20, 1944.

A careful investigation was made of 500 patients from a naval depot after a large film had confirmed an abnormality seen in the miniature film. The patient was kept in bed for five days, during which time clinical examination was carried out, a four-hourly chart kept, sputa and gastric contents were examined for tubercle bacilli, intradermal tuberculin tests were done, the erythrocyte sedimentation rate was estimated, the weight recorded and, if necessary, another chest roentgenogram was taken. The case was then reviewed and placed in one of the groups described below or the patient was referred for continued observation in the hospital or as an outpatient. None of these patients had reported sick. Any symptoms were minimal and had been regarded as insignificant. Often the examiners were unable to detect any abnormal physical signs in cases showing gross roentgenologic changes, from which it is concluded that physical signs in the chest are relatively unimportant.

The 500 cases were distributed among the following groups: Group 1, fit for duty, 134 men; Group 2, recommended three months' observation on shore duties, 143 men; Group 3, active tuberculosis, bacteriologically positive, 69 men; Group 4, active tuberculosis, bacteriologically negative, 69 men; Group 5, lesions of tuberculous origin with no evidence of activity but likely to break down under service conditions, 29 men; Group 6, non-tuberculous "pneumonitis," 22 men; Group 7, unfit for service on account of other diseases, 34 men. Group 2 consisted largely of men over 25 years of age with doubtful roentgen changes but with no other evidence of active disease. Group 5 was made up mainly of young men, from 18 to 22, with small round or oval opacities usually in the upper zone with no other evidence of active disease.

These 500 cases form a part of a series of 44,000 previously analyzed by Brooks (*Proc. Roy. Soc. Med.* 36: 155, 1943. *Abst. in Radiology* 41: 600, 1943).

**Management of Minimal Pulmonary Tuberculosis Disclosed by Fluorography.** W. D. W. Brooks. *Lancet* 1: 745-748, June 10, 1944.

Fluorography of 479,373, apparently healthy male personnel of the Royal Navy showed that 6,077 (12.7 per 1,000) had radiological signs of adult-type pulmonary tuberculosis. In 47.9 per cent of these the lesion was "minimal." By minimal tuberculosis the authors mean adult (reinfection) type pulmonary tuberculosis which, as shown roentgenologically, consists of infiltration without demonstrable cavitation affecting a volume of lung (regardless of distribution) which does not exceed that volume of lung tissue lying above the second chondrosternal junction and the body of the fifth thoracic vertebra on one side. In some of the minimal cases the disease is arrested or is retrogressive, but in others it is progressive. Of the 2,911 sailors with minimal lesions who were studied in the hospital, 16 per cent showed evidence of active infection; in 63 per cent, the disease appeared to be inactive, but the stability of the lesions was doubtful; in 21 per cent the lesion was inactive.

Of 23,344 WRNS, 213 (9.1 per 1,000) had roentgen evidence of tuberculosis, and the lesion was minimal in 55.4 per cent. In 18 per cent, the lesion was considered active.

Naval personnel with apparently inactive minimal tuberculosis were placed on light shore duties and kept under observation. Study of these cases shows that the younger the patient the more likely is the disease to become active and the relapse to be serious. The findings indicate that a diagnosis of apparently inactive minimal tuberculosis in males under fifty should imply outpatient supervision, with regular inpatient re-examination during the next two years. For patients under thirty, this observation period should probably be longer.

Similar investigations among civilians will no doubt bring to light a large number of cases of pulmonary tuberculosis of slight degree, raising difficult problems of disposal and treatment.

**Cavernous Breathing: Is There Such a Sound?** George G. Ornstein. *Dis. of Chest* 10: 407-414, September-October 1944.

Cavernous breathing, so-called, was originally described by Austin Flint as an inspiratory blowing sound, low in pitch and non-vesicular in quality, with an expiratory sound of lower pitch of the same quality, and of variable length and intensity. The author does not believe that such sounds are produced by a cavity and is of the opinion that Flint mistook exaggerated vesicular breathing, which is frequently found in the vicinity of tuberculous infiltration, for evidence of cavity formation. In support of his view, the author presents a series of roentgenograms, made by the tomographic technic, with observations on the nature of the breath sounds in the cases illustrated. He concludes that the most common finding over a cavity is diminished broncho-vesicular breathing often accompanied by high-pitched moist râles. Thin-walled check-valve cavities are frequently silent. Uninvolved lung tissue overlying a cavity may produce vesicular breath sounds. A cavity in an old atelectatic lobe may transmit tracheal or bronchial sounds—frequently but erroneously called broncho-cavernous breathing. HENRY K. TAYLOR, M.D.

**Lobar, Broncho-, and Atypical Pneumonia; A Study of Five Hundred Cases.** Albert W. Hobby. *U. S. Nav. M. Bull.* 43: 438-449, September 1944.

The author analyzes 500 cases of pneumonia seen at a U. S. Naval Hospital from Oct. 1, 1941, to Jan. 1, 1944. They are grouped as lobar pneumonia, 112 cases; bronchopneumonia, 62 cases; atypical pneumonia, 326 cases. Monthly distribution charts reveal a striking increase in the incidence of the atypical form.

The usual x-ray findings in lobar and bronchopneumonia are described. The x-ray findings in the atypical pneumonias, among which the author includes the influenzal pneumonias, vary greatly. A confluent mottling, usually of homogeneous density, in the central portion with the borders fading into normal lung tissue, was found to occur anywhere in the lung, and not just at the hilus with extension into the parenchyma, as described elsewhere in the literature. In this group of cases, the pneumonic process usually occurred in the lower half of the lung.

The author believes that atypical pneumonia should be considered as a phase of an upper respiratory infection which has gravitated to the lungs. He would divide the syndrome into a bronchitic, a peribronchitic,

an alveolar, and a broncho-alveolar phase. Any phase may exist independently or coincidental with the other phases.

The usual therapy was employed, with success, in all types of pneumonia. In addition, x-ray therapy was found of value in the atypical cases. It not only afforded subjective relief but also reduced the number of hospital days by as much as one-fourth in some cases.

STANLEY H. MACHT, M.D.

**Pneumonitis Associated with Malaria.** I. L. Applebaum and Joel Shrager. *Arch. Int. Med.* 74: 155-162, September 1944.

One hundred and twenty-five consecutive patients with pneumonitis associated with malaria admitted to Gorgas Hospital from January 1942 through May 1943 were studied. Most of these patients (70 per cent) were young white men attached to the military personnel. The incidence of pneumonitis in persons with malaria in the military group was 3.7 per cent. The occurrence was greatest during the rainy season, when both malaria and primary pneumonitis were most frequently encountered as separate entities. Acute and gradual onset of symptoms occurred with equal frequency. Symptoms in the upper respiratory tract preceded constitutional manifestations in 20 per cent of the cases. The chief complaints in order of frequency were: fever, cough, chills, headache, expectoration, malaise, general aches, gastro-intestinal symptoms, pain in the chest, disturbances in the upper respiratory tract, and excessive sweats. The chief physical findings were râles, bronchovesicular breath sounds, and dullness. There was an absence of objective signs in 36 per cent of the cases, attesting to the importance of roentgen examination. Positive findings referable to malaria were not prominent.

In 121 of 125 cases, or 97.8 per cent, roentgen examination was utilized for diagnostic purposes. The lesions were mainly of lower lobe distribution and of the lobular type. There were no serious complications.

Cases of estivo-autumnal and of tertian malaria associated with pneumonitis were about equal in number. There was no significant difference between the two groups in the clinical course or response to therapy.

Many of the patients with pneumonitis exhibited adequate response to antimalarial therapy; a fair proportion reacted favorably to sulfonamide compounds, and in a number the disease ran its course unaffected by treatment. On the basis of this study, pneumonitis in malaria is classified as follows: (1) atypical or virus pneumonitis with inadequate response to the therapy employed, running a self-limited course; (2) bacterial pneumonitis, with adequate response to sulfonamides; (3) malarial pneumonitis, with favorable response to antimalarial drugs.

**Bronchial Obstructions in Primary Pulmonary Tuberculosis.** W. F. Richards. *Proc. Roy. Soc. Med.* 37: 589-592, August 1944.

Of 239 children under six years of age suffering from primary tuberculosis of the lungs, 50 (21 per cent) experienced a sector or lobar collapse due to bronchial obstruction. Above this age, the incidence of the complication was less—7 per cent of 114 children whose ages ranged from six to nine years, and 6.5 per cent of 92 children over ten.

In this series the right middle bronchus was involved

23 times out of a total of 66 affected lobes. Next came involvement of the right lower lobe or right basal bronchi, 13 times. The right and left upper lobes were equally involved, with 9 collapses each, and the left middle lobe or lingula and left base were affected in 6 cases each. In 4 children more than one lobe was involved. In 32 of the 64 cases, re-expansion occurred without incident. The shortest time from collapse to spontaneous re-expansion was one month; the longest, while under observation, was two years. In 10 of the 64 patients, or 15.6 per cent, bronchiectasis developed. Twenty-two, or 34.4 per cent, still had their collapse on discharge.

ELLWOOD W. GODFREY, M.D.

**Obstructive Emphysema in Infancy Due to Tuberculous Mediastinal Glands. Report of a Case.** L. G. Pray. *J. Pediat.* 25: 253-256, September 1944.

A case of obstructive emphysema of the left lung in a 4 1/2-month-old infant is presented. The child was seen three or four days after the onset of the illness, which began with difficulty in breathing. Respirations were extremely labored and rapid, with supraclavicular bulging on expiration and deep retraction on inspiration. The percussion note was resonant throughout and somewhat hyperresonant over the left chest. The breath sounds were short, more so on the left than on the right. X-ray examination of the chest showed an obstructive emphysema of the left lung, with secondary inflammatory changes in the perihilar region. The mediastinum was shifted to the right, and there was compression of the right upper lung field. There was no opaque foreign body or obstructing lesion of the left main bronchus, but on bronchoscopy changes due to external compression were demonstrated. A tracheotomy produced temporary relief, but the child died the second day after hospital admission. Autopsy showed the compression of the bronchus to be due to tuberculous tracheobronchial lymph nodes.

**Bronchiolitis in Children.** G. H. Newns. *Proc. Roy. Soc. Med.* 37: 580-585, August 1944.

Acute bronchiolitis has been previously described under the designations capillary bronchitis and interstitial bronchopneumonia. While it is not a common disease, the incidence rises sharply in epidemics of influenza; it may also accompany measles or pertussis, or arise independently of these diseases. An important etiologic factor is the predisposing influence of a virus infection which makes possible the invasion of bacteria and enormously intensifies their effects.

Pathologically bronchiolitis is divided into the catarrhal and mural types. In the catarrhal type the mucous membrane alone is involved, while the wall is unaffected. The mural type is further divided into simple, proliferative, and destructive phases. The incidence and severity are greatest in childhood. The typical onset is that of a mild tracheobronchitis, soon succeeded by more severe symptoms, consisting of rapid respiration, high fever, obstructive dyspnea, cyanosis, prostration, and collapse. The greatest difficulty seems to be in getting air into the lungs. The disease may be confused with bronchopneumonia; but here the x-ray is helpful, as gradations from nothing definitely abnormal to a diffuse, fine mottling, often very faint, but occasionally so marked as to simulate miliary tuberculosis, are seen on the film.

ELLWOOD W. GODFREY, M.D.

**Eosinophilic Infiltration of the Lungs (Loeffler's Syndrome).** Stewart H. Jones and Carlton R. Souders. *New England J. Med.* 231: 356-358, Sept. 7, 1944.

The exact pathological nature of the syndrome first described by Löffler in 1932 is unknown, since no deaths have been reported. The cause also is undetermined but is believed to be in the nature of an allergy, since the condition is associated with vasomotor rhinitis and asthma. It has been found in association with parasitic infections and brucellosis.

The patient complains of a metallic taste, cough, wheezing, and malaise. There is a slight fever, and diminished resonance and sibilant râles are elicited over the area of pulmonary consolidation. Blood examination shows a leukocytosis, eosinophilia of 10 to 60 per cent, and increased sedimentation rate.

Roentgenographically the pulmonary infiltrations are indistinguishable from pulmonary tuberculosis, with clear and irregular outlines. The shadows appear rapidly, disappear in three to eight days, only to appear elsewhere in the lungs. The lesion may be single, multiple, unilateral, or bilateral.

This condition may be mistaken for tuberculosis, bronchiectasis, neoplasm, or so-called abortive pneumonia.

JOHN B. McANENY, M.D.

**Transitory Migratory Pulmonary Infiltrations Associated with Eosinophilia (Loeffler's Syndrome), with the Report of an Additional Case.** J. Winthrop Peabody. *Dis. of Chest* 10: 391-406, September-October 1944.

Löffler's syndrome is a transitory migratory pulmonary infiltration demonstrable on serial roentgenographic examinations, associated with an eosinophilia. The clinical course is mild and symptoms may be minimal. On physical examination there may be no findings, or a few moist and sibilant râles over the areas of consolidation. Roentgen examination shows small or large areas of consolidation which appear and disappear suddenly in various parts of the lungs, most often in the lower fields. The roentgen findings may simulate the adult type of pulmonary tuberculosis. The eosinophilia is sometimes accompanied by a moderately high leukocytosis and a slightly elevated sedimentation rate. There is no parallelism between the degree of eosinophilia and the extent of pulmonary involvement.

The pathogenesis is undetermined; it is thought to be on an allergic basis. The etiologic agent or agents have not been identified, but intestinal parasitism may be a factor.

A case is reported with a high degree of eosinophilia and pulmonary infiltration which variously involved one lung and both lungs, varying as to location, and disappearing completely at intervals.

HENRY K. TAYLOR, M.D.

**Cystic Disease of the Lung with Iodized Oil Studies.** H. Vernon Madsen and H. B. Pirkle. *Dis. of Chest* 10: 433-441, September-October 1944.

The authors review the literature on cystic disease of the lung. There is no general agreement as to whether the condition is congenital or acquired. Pearce (*Am J. Roentgenol.* 44: 848, 1940) believes that most cases are acquired. Two anatomical types are recognized: (1) bronchial dilatations, with muscle tissue and cartilage in the walls, and (2) subpleural cavities resembling emphysematous blebs. The cysts

may be single or multiple, unilocular or multilocular, small or large, oval or spherical, and may contain fluid or air, or both. The adjacent alveoli may be atelectatic or may have failed to develop. Symptoms include dyspnea, cyanosis, cough, palpitation and, rarely, hemoptysis.

The roentgen appearance varies, being dependent upon the location, size, number, and content of the cysts and the absence or presence of concurrent disease. Fluid-filled cysts may resemble neoplasms, hydatid or dermoid cysts, or aneurysm. Even after careful study, it may be necessary to make a non-specific diagnosis of tumor of the lung. An infected fluid-filled cyst surrounded by an irregular zone of reactive inflammation resembles and in most cases will be mistaken for an abscess or pneumonic consolidation. Cysts containing both air and fluid must be differentiated from abscess, tuberculous cavitation, and draining hydatid cyst. Large air-filled cysts can be distinguished roentgenologically with a high degree of accuracy. They usually are single or do not exceed two or three in number. There is a radioparent area devoid of normal pulmonary markings, and the part of the wall of the cyst in contact with the lung appears as a regularly curved line or lines. For cases offering difficulty in diagnosis a number of special procedures are suggested. In the authors' case an artificial pneumothorax was established and 10 c.c. of iodized oil were injected into the pleural space. The patient was then placed in the horizontal position, with the head lower than the feet, and was rolled forward and backward (being observed at the same time under the fluoroscope) to distribute the iodized oil over the surface of the pleura. Roentgenograms made immediately following this procedure clearly demonstrated the cystic spaces.

Treatment is in general unsatisfactory. In the authors' case it had not been attempted.

HENRY K. TAYLOR, M.D.

**Broncholithiasis.** Walter S. Anderson and J. B. Mackay. *Dis. of Chest* 10: 427-432, September-October 1944.

Broncholithiasis is of rare occurrence. The stones may be endobronchial in origin but more often enter the bronchus from without, following erosion of the wall. Most frequently they represent the end stage of a primary tuberculous lesion in the tracheobronchial lymph nodes, though they may result from other types of pulmonary inflammation or suppuration. In most of the reported cases the diagnosis was made following expectoration of the stones. Roentgen examination discloses evidence of either partial or complete obstruction of a bronchus, but bronchoscopy is required for differentiation from bronchiogenic carcinoma. In the author's case, however, swelling proximal to the obstruction, involving the curve of the bronchus, prevented bronchoscopic visualization of the lesion and showed only normal mucosa. The patient was a woman of 33 with a history of cough and recurrent hemoptyses. Roentgenography following lipiodol injection showed an obstruction of the right middle bronchus. This was interpreted as bronchiogenic carcinoma. Lobectomy was performed and 3 broncholiths lying in an ulcerated area were found. These concretions originated in a calcified lymph node which had perforated the bronchus, eroding a blood vessel in the process.

HENRY K. TAYLOR, M.D.

**Pneumoconiosis in Boiler-Scalers.** P. G. Todd and David Rice. *Lancet* 1: 309, March 4, 1944.

An additional case of pneumoconiosis in a boiler-scaler is reported. Roentgen examination showed a "snow-storm" type of infiltration of both lungs equal in intensity from hilum to periphery, suggesting either military tuberculosis or pneumoconiosis. No tubercle bacilli were found in the sputum.

**Cadmium Poisoning in Industry: Report of Five Cases, Including One Death.** Louis W. Spolyar, J. F. Keppler, and Herman G. Porter. *J. Indust. Hyg. & Toxicol.* 26: 232-240, September 1944.

Five cases of cadmium poisoning in industry, with one death, are reported. Cadmium poisoning, by way of the respiratory route, produces few immediate symptoms. Within four to eight hours patients complain of irritation of the throat, headaches, and cough. Some twenty to thirty-six hours after exposure symptoms develop suggesting pulmonary edema—dyspnea, pain in chest, and persistent cough. Among the 59 reported cases in the literature, there were 9 deaths, a mortality of 15 per cent. Death was found to occur from the fifth to seventh day after exposure. Recovery ensues within a period of seven to eleven days after exposure. X-ray examination of three of the cases reported here, four weeks after exposure, showed the men to be free of residual chest lesions.

**Pulmonary Changes in Chronic Cystic Pancreatic Disease.** George J. Baylin. *Am. J. Roentgenol.* 52: 303-306, September 1944.

Andersen (*J. Pediat.* 15: 763, 1939, and *Am. J. Dis. Child.* 56: 344, 1938) described certain striking changes seen in a number of infants who succumbed to pulmonary infections. She found that the pancreas was small and irregular and that microscopically it was composed of small and large cysts lined with epithelium. The ducts were usually embedded in masses of fibrous tissue. The lungs in all cases showed bronchitis and bronchopneumonia; bronchiectasis and atelectasis were frequently observed.

This condition, now recognized as a clinical entity, is observed for the most part in infants dying from bronchopneumonia or other pulmonary lesions before the age of six months. A smaller group survive for longer periods, up to fourteen years, presenting the so-called celiac syndrome. In another small group—about 10 per cent of the total—death occurs in the first two weeks of life.

The underlying disease process is apt to go unrecognized. The hilar regions of the lungs show marked involvement characterized roentgenologically by areas of increased mottled density. Toward the periphery there are streaking and mottling which is much less pronounced. Evidences of atelectasis and bronchiectasis may also be observed. The roentgen picture is so consistent that, even though it cannot be considered absolutely diagnostic, it should invariably arouse suspicion of fibrocystic pancreatitis. Secondary changes in the physiology of the intestinal tract—hypomotility associated with some dilatation of the small intestine—may be demonstrable on a plain film or in barium studies.

The relationship between the pancreatic and pulmonary lesions is obscure. Deficiency in fat absorption and metabolism may lead to vitamin-A deficiency,

which results in serious epithelial changes in the lungs. It is also possible that a coexisting congenital abnormality of the pancreas and lungs exists. The prognosis is poor. There are some instances on record in which intensive supportive and vitamin therapy resulted in at least temporary clinical improvement.

CLARENCE E. WEAVER, M.D.

**Blastomycosis of the Skin (Gilchrist Type) with Associated Blastomycetic Pulmonary Disease. Report of a Case.** Arthur Sayer. *U. S. Nav. M. Bull.* 43: 333-342, August 1944.

Cutaneous blastomycosis is not a common disease in this country. It may be accompanied by or be a part of generalized blastomycosis. It is a chronic inflammatory disease of the skin producing sharply elevated verrucose patches of varying size with a characteristic sloping border in which are the blastomycetes. The lesions occur most frequently on the face, wrist, and forearm. When the disease becomes generalized, the lungs, liver, kidneys, spleen, and bones may be involved. The mortality in systemic cases is reported at 90 per cent.

Sayer presents a case which exhibits most of the characteristic changes of cutaneous blastomycosis. The disease was originally diagnosed in 1939 and, when first seen by the author, had been present over four years. The patient had extensive lesions on the right side of the face and neck, involving also the eyelids, and a separate lesion of the left elbow. He had been on more or less continuous potassium iodide therapy for three years. He had also received x-ray therapy to the skin lesions; the exact dosage was not known but was apparently sufficient to have produced permanent skin damage, in the opinion of the author. For this reason no additional x-ray therapy was given, but the iodide therapy was increased until the patient was receiving as much as 420 grains of potassium iodide daily by mouth and 31.5 grains of sodium iodide intravenously. The oral dose was later increased to 480 grains per day and the injections were discontinued. There was definite improvement in the cutaneous lesions with this therapy.

Included in the article are reproductions of two chest roentgenograms from this case. The author states that a diagnosis of blastomycosis of the lungs was made on the roentgen findings. He also states that, after three months of the highly intensified iodide therapy, the chest film showed a marked improvement. [The reviewer believes that many of the changes present in these roentgenograms could be ascribed to apical pulmonary tuberculosis, which was one of the original diagnoses in this case before cutaneous blastomycosis developed.] In addition to the iodide treatment, the patient was given sulfadiazine and two million units of penicillin with no benefit. The iodide therapy was being continued at the time of the report, since it was the only treatment which had been efficacious.

BERNARD S. KALAYJIAN, M.D.

**Posterior Mediastinal Goiter.** J. M. Mora, H. J. Isaacs, S. H. Spencer, and L. Edidin. *Surg., Gynec. & Obst.* 79: 314-317, September 1944.

The authors report a case of posterior mediastinal goiter, the seventh to be recorded. The patient was a 55-year-old white woman who had been studied for eight years by many physicians. All, on roentgen ex-



amination, had observed a large shadow occupying the right upper lung field. Basal metabolic determinations on a number of occasions had been reported normal. Roentgen examination by the authors showed a large globular mass in the posterior mediastinum. They found, also, the classic signs and symptoms of hyperthyroidism, with a basal metabolic rate varying between +45 and +51. A diagnosis of thyrotoxicosis was made, and the mass was believed to be a large intrathoracic goiter. On operation, this diagnosis proved correct, the goiter being of the adenomatous type. The patient made an uneventful recovery, and the basal metabolic rate one year later was +6.

The authors state that the descent of these thyroid masses is brought about by a number of factors, including breathing, swallowing, muscular activity in flexing and rotating the head, and gravity. Some patients are without symptoms; some exhibit evidence of thyrotoxicosis with or without pressure symptoms. Anteroposterior and lateral roentgenograms will substantiate the clinical diagnosis. Fluoroscopic observation of movement of the mass on deglutition is of particular significance. Treatment consists in surgical removal.

N. P. SALNER, M.D.

**Angle of Clearance of the Left Ventricle as an Index to Cardiac Size: Modified Technic for Its Determination and Range of Values for Normal Children.** Robert L. Jackson, Robert A. J. Einstein, Aliee Blau, and Helen G. Kelly. *Am. J. Dis. Child.* 68: 157-162, September 1944.

The authors describe a modification of the Wilson technic for the determination of the angle of clearance of the left ventricle, *i.e.*, the amount of rotation of the subject necessary to separate the left lower border of the cardiac silhouette (left ventricle) from the vertebral column, on fluoroscopic examination in the left anterior oblique position.

With the original Wilson technic, two major difficulties were encountered. First, it was found that the left border of the cardiac shadow clears the spinal column at two points: (1) the point of separation from the projection of the transverse processes of the spine; (2) the point of separation from the anterior border of the vertebral bodies. There was a difference of approximately 10° between these two angles of clearance. A second difficulty lay in minor changes in the position of the patient. To obviate errors caused by position or posture change, the authors used a stool with an adjustable foot-rest and back, constructed on a turntable, and examined the subject in a sitting rather than in the usual standing position. Both angles of clearance were measured.

Sixteen normal children received from eight to thirteen examinations each, three or four at one session. The mean value of the repeated measurements was assumed to be the true angle of clearance. Not over 10 per cent of the single measurements varied more than 5° from the true value. For 11 of the group, or 69 per cent, the mean deviation from the true value was less than 3.5° for both clearance angles.

Having thus determined the reliability of this method of study, the authors examined 102 normal children to ascertain the range of values in the absence of cardiac disease. In this group, the values for the first angle of clearance ranged from 38 to 67°, with a mean value of 51.8° and a standard deviation of 5.8°. The values for the second angle of clearance ranged

from 46 to 86°, with a mean value of 63.2° and a standard deviation of 7.4°. Patients with vertically placed hearts showed a smaller angle of clearance than those with transversely placed hearts. Neither age nor sex showed any significant influence on the measurements.

The procedure should be valuable clinically for the determination of changes in the heart size during the course of rheumatic or other cardiac disease.

•LESTER M. J. FREEDMAN, M.D.

**Cor Biatratrium Triloculare. Case Report.** Margaret M. Glendy, R. Earle Glendy, and Paul D. White. *Am. Heart J.* 28: 395-401, September 1944.

The authors report an unusual case of absence of the ventricular septum in a boy seen by them at the age of 9 years. He had been known for two years to have heart disease, but had led an active life up to three weeks before his admission to the hospital with a terminal infection. The most notable feature in the case was the absence of any history of cyanosis except on swimming. Even terminally, cyanosis was of only slight degree.

Successive roentgenograms revealed a greatly enlarged heart and pulmonary congestion. The last one, made on the day before death, five weeks after admission, showed a further increase in the cardiac size, with a change in contour suggesting a pericardial effusion. A pericardial tap was attempted but only dark blood was obtained. The clinical diagnosis was acute and chronic rheumatic heart disease, with acute cardiac dilatation and failure.

Postmortem examination revealed a very large heart, with the ventricular wall measuring 22 mm. in thickness and a patent foramen ovale 1 cm. in diameter. There was a single large ventricular cavity with a small outpocketing representing the rudimentary left ventricle or bulbus. From the large ventricular cavity the aorta arose at the anterior upper left margin, its base forming the bulb just mentioned. All the valves except the mitral appeared smooth and competent. The mitral valve was thickened along its free border, but no vegetations were present. The pulmonary artery was dilated and its diameter was several times that of the aorta. Just beyond the site of the subclavian artery there was slight to moderate coarctation of the aorta, which measured 8 mm. in diameter.

The authors believe that the absence of cyanosis in this case may be explained in part by the fact that the location of the aorta was such that the arterial blood returning *via* the mitral valve probably formed a barrier against too great admixture with venous blood returning *via* the tricuspid valve. If this assumption is correct, the blood leaving the heart through the aorta must have been predominantly arterial. Secondly, the great size of the pulmonary artery, as compared with the aorta, served the process of oxygenation of the blood well until dilatation and failure of the heart made this no longer possible.

HENRY K. TAYLOR, M.D.

**Corvisart's Disease [Tetralogy of Fallot with Right-Sided Aortic Arch].** A. Castellanos, Raúl Pereiras, and Argelio García López. *Bol. de la Soc. cubana de pediat.* 16: 329-353, September 1944.

The authors employ the term Corvisart's disease [usually applied to chronic hypertrophic myocarditis]



to designate the combined finding of the tetralogy of Fallot and right-sided aortic arch, an association first described by Corvisart in 1918. Seven cases in children from 4 months to 9 years of age are reported. An extensive history of each is given, and the clinical diagnosis is supported by angiocardiograms reproduced in the text. It is claimed that these are the first such cases to be reported in Cuba and the first to be diagnosed in infants before death.

Emphasis is placed on the necessity of investigating thoroughly the aortic arch of every patient presenting atypical mediastinal symptoms, especially in adult life.  
A. MAYORAL, M.D.

**Congenital and Infantile Beriberi.** David W. Van Gelder and Francis U. Darby. *J. Pediat.* 25: 226-235, September 1944.

The authors review the literature on congenital and infantile beriberi and report a case of the congenital type.

An apparently well nourished male infant showed signs of cyanosis immediately after birth. A few fine crackling râles were heard over the bases of both lungs posteriorly. The area of cardiac dullness was increased. The heart rate was so rapid that the apex beat could not be counted. The liver edge was palpable, but the liver did not appear to be enlarged. During the first day, despite continuous administration of oxygen, the infant had several cyanotic attacks. A roentgenogram of the chest, taken at eighteen hours, showed cardiac enlargement. On the second day, the cry was hoarse and feeble, and cyanotic attacks became more frequent and severe. At thirty hours, convulsive movements, with rigidity of the extremities, developed.

Subcutaneous administration of thiamine hydrochloride (50 mg.) at forty-two hours and again eight hours later was followed by dramatic improvement, and the injections were continued at eight-hour intervals for eleven days without apparent toxic effect. The area of cardiac dullness was reduced by the third day following the initial injection, and the heart rate decreased to 160 per minute. A roentgenogram at two weeks of age showed a considerable reduction in the cardiac shadow.

Thiamine chloride was gradually reduced to 50 mg. daily by the third week of life, at which time the pulse rate was 130. When the injections were discontinued, the pulse again rose to 160, but with oral administration of a vitamin B complex it fell, after a month, to 135. By the seventh week of life, the electrocardiogram, which had previously revealed definite evidence of myocardial disease, was normal except for sinus tachycardia. A film of the chest at eight weeks showed a heart of normal size, and the physical findings at that time were apparently normal. One month later dilated pupils and homogeneous, apparent soft opacities of both lenses were observed. (It is believed that the cataracts were present at birth and were due to the metabolic disturbance resulting from the vitamin B<sub>1</sub> deficiency during intra-uterine life.)

The mother of the infant was observed by the authors during the last trimester of her pregnancy. Despite a wholly inadequate prenatal diet, she did not exhibit any marked clinical signs of beriberi. A slight edema during the last trimester was originally attributed to a mild toxemia, despite normal blood pressure and negative urinalyses. Postnatal urinary

thiamine assays and dextrose, pyruvate, and lactate blood levels, fasting and following ingestion of dextrose, indicated a state of thiamine deficiency.

The authors mention the possibility that some cases of "congenital idiopathic cardiac hypertrophy" or "status thymicolymphaticus" may actually be instances of unrecognized congenital or infantile beriberi.

## THE DIGESTIVE SYSTEM

**Argentaffin Tumors of the Gastrointestinal Tract.** Gorton Ritchie and William T. Stafford. *Arch. Path.* 38: 123-127, September 1944.

Eleven cases of argentaffin tumors were encountered in an autopsy series at the Wisconsin General Hospital. In 3 of these cases (27.2 per cent) the tumor was classed as metastasizing. In one case the mesentery and mesenteric lymph nodes were invaded; in the second, both the mesentery and the liver were involved; in the third, which is reported here, widespread abdominal metastases were found. These cases bring the total number of argentaffin tumors recorded to date to 332, in 126 of which (37.9 per cent) metastases are known to have occurred.

The clinical picture associated with these tumors is variable. In 3 of the 11 cases in this series, clinical evidence of obstruction was present. In the case recorded the chief complaints were pain in the stomach and diarrhea, present for nine months. Roentgen examination revealed a calcified myoma of the uterus, downward displacement of the right kidney, and enlargement of the liver. Complete studies of the gastro-intestinal tract showed no abnormalities. Blood in the stool, detected at first only by the guaiac test, increased until at the time of autopsy a large amount of tarry feces was present below the site of the lesion. The origin of the melena in this case cannot be definitely ascribed to ulceration of the tumor, as the gross picture of the initial lesion was obscured by necrosis of the involved segment of ileum. The appearance of blood in the stools may have been the result of this necrosis in spite of the fact that x-ray studies of the intestine two days prior to death demonstrated no lesion. It is probable that the vascular lesion caused by extension of the tumor was a gradual process with slowly extending necrosis.

Cases of argentaffin tumor metastasizing to the spleen are uncommon. Only two cases have been recorded previously in which the splenic metastases were unquestionably of hematogenous origin, with neoplastic cells deep in the splenic pulp. In the authors' case, the microscope revealed a typical argentaffin tumor primary in the ileum with metastases in the mesentery, the mesenteric lymph nodes, the wall of the gallbladder, the liver, the spleen, and the peritoneal surfaces. From the peritoneal implants there was invasion of both ovaries and the wall of the descending colon. The splenic metastases were microscopic in size. One was found just beneath the capsule and several in the deeper portions of the parenchyma. One small artery was filled with tumor cells.

For some years the argentaffin tumor was considered non-cancerous and the term "carcinoid" was proposed. The increasing number of reported cases with metastases has established the tumor as a true carcinoma. It is proposed that the term "carcinoid" be discarded and the terms "benign argentaffin tumor" and "argentaffin carcinoma" be used. The clinical diagnosis

of argentaffin tumor is of great importance, since the proportion of cases in which the tumor is non-cancerous is high and surgical treatment offers a good prognosis.

**Leiomyoma of the Jejunum: Intermittent Melena of Fourteen Years Duration, and Fatal Hemorrhage.** Harold A. Hanno and Maurice Mensh. *Ann. Surg.* 120: 199-206, August 1944.

A case of leiomyoma of the jejunum, with twenty known episodes of melena over a fourteen-year period and a fatal termination, is reported. Repeated roentgen examinations, including progress-meal studies, revealed no lesion in the upper gastro-intestinal tract or colon. A gastro-enterostomy was performed three years after the onset of symptoms, although at operation no ulcer of the stomach or duodenum could be found. Several gastroscopic examinations in the period following gastro-enterostomy showed no evidence of bleeding points or ulceration either in the body of the stomach or the well visualized stoma. A tumor of the jejunum was found at autopsy.

This case emphasizes the fact that much too frequently the presence of a neoplasm of the intestine is not suspected. This possibility should be considered in any patient who has repeated episodes of melena in the absence of a demonstrable lesion in the upper gastro-intestinal tract or colon, and in any patient with recurrent partial or complete obstruction of the small bowel.

Roentgenography is of assistance in the diagnosis in many but not all cases of tumor of the small bowel. There are several reasons for the failure of this procedure. Perhaps the most important of these is that the clinician fails to suspect a tumor and, as a consequence, the roentgenologist, not being forewarned, does not look for such a lesion with sufficient care or persistence. Secondly, subserosal tumors, which accounted for two-thirds of the cases of myoma in one series, are unlikely to produce a marked subtraction defect in the silhouette of the barium-filled small bowel. Thirdly, due to the extensive overlapping of small bowel shadows, a defect may easily be overlooked. Repeated progress-meal studies and, in some cases, the introduction of barium directly into the jejunum through a tube are prerequisites for adequate demonstration of small intestinal neoplasms. If obstruction is present, plain films of the abdomen will reveal the usual roentgen evidences of dynamic ileus, and in those cases of colonic involvement by an intussuscepting mass in the small intestine, barium enema studies are of value.

**Diverticula and Duplications of the Intestinal Tract.** J. L. Bremer. *Arch. Path.* 38: 132-140, September 1944.

While this paper is not written from the point of view of the radiologist, he will find its discussion of those anomalies of the intestinal tract known as "duplications" or "reduplications," "enteric" or "enterogenic cysts," "ileum duplex," and "giant diverticula" of interest. The author's conclusions constitute a good summary:

"The group of anomalies comprising the enterogenic cysts, intestinal duplications and the like is divisible into two smaller classes on the basis of embryologic origin. Most of the spherical cysts are derived from true diverticula, which are frequently found projecting from the ventral or antimesenteric

surface of the tube in embryos of the eighth or ninth week and are normally absorbed later. Abnormally they continue to grow: If restricted by the intestinal muscle, they bulge within the lumen, but if they pierce the muscle layers, outward expansion is not limited and they may become large cysts attached to the intestine. Their wall is necessarily thinner than the gut wall.

"A few of the spherical and most of the tubular structures represent true duplication, originating by an abnormal persistence of the vacuoles normally present among the massed cells of the 'solid stage' of the intestine, a phenomenon of growth in embryos of the sixth or seventh week. By the confluence of a chain of vacuoles a new channel is formed, parallel to the original lumen, and becomes separated from the latter by a union of the intestinal layers between the two. Since the duplication develops within the intestine, the outer wall of the duplicate portion always contains all of the tissue layers of the intestine. The duplicate lumen usually lies between the leaves of the mesentery but may be entirely separated, with a mesentery derived by the splitting of the original. It may open into the main lumen at one or more places, or become a closed cyst. Theoretically, three or more channels are possible, the main lumen and two or more confluent chains of vacuoles.

"The duplicate structures assume many forms . . . and are often associated with other anomalies. In the tubular portions the mucosa tends to resemble that of the parent tube, but in bulbous or cystic portions it changes to the gastric type. Great internal pressure may destroy mucosa of any type."

**Congenital Anomalies of the Lower Part of the Rectum: Analysis of Sixteen Cases.** Madison J. Lee, Jr. *Am. J. Dis. Child.* 68: 182-189, September 1944.

Congenital malformations of the anus and rectum are uncommon, occurring in 1 out of 5,000 infants. They result from imperfect separation or obliteration of cavities and failure of proper rupture of the anal membrane. This is indicated by a review of the embryology of the five- to eight-week fetus from the formation of the urogenital sinus and cloaca to its separation into the urogenital system and rectum and concurrent dimpling of the proctoderm with formation and eventual dissolution of the anal membrane. It is mentioned incidentally that the external anal sphincter develops from the local mesenchyme, independent of the lower bowel segment, and may be present notwithstanding local anomalies.

The author reports in adequate detail 16 cases of anorectal malformations collected from three hospitals over a four-year period. He has used the classification of Ladd and Gross (*Am. J. Surg.* 23: 167, 1934), which is as follows:

- Type 1.* Incomplete rupture of the anal membrane or stenosis at a point 1 to 4 cm. above the anus.
- Type 2.* Imperforate anus due to a persistent anal membrane.
- Type 3.* Imperforate anus with the rectal pouch separated from the anal membrane. The rectal pouch is a closed sac.
- Type 4.* Normal anus and anal pouch with a blind rectal pouch. There is either membranous obstruction or considerable separation between the two pouches.

Eleven of the 16 cases were of Type 3, and 4 of Type 1. The remaining case was considered a combination of Types 1, 2, and 4. No case of pure Type 2 was included in this series. It is believed that the simple remedy of cruciate membrane incision may have proved so satisfactory in these cases that they failed to attract any special attention.

Absence of meconium, signs of abdominal obstruction, bulging of the perineum on straining to defecate, ribbon stools, and the appearance of meconium or fecal material from the urethra, vagina, or sinus openings indicate the presence of a rectal anomaly. Roentgen examination aids in the precise diagnosis and localization of the defect needed for proper surgical treatment. Blind rectal pouches can often be delineated by fluoroscopic or roentgenographic study. Fistulas can be traced with the use of iodized oil.

Associated anomalies are rectovesical, rectourethral, and rectoperineal fistulas in the male infant; rectovaginal, rectovesical, rectoperineal, fistulas and fistulas between the rectum and the fossa navicularis in the female.

The case of combined anomalies of Types 1, 2, and 4 is of interest. The patient was a white male infant born with an apparent imperforate anus and hydrocele. A blunt instrument was pushed through the membrane at the anal dimple, and continuity with the rectum was established. Meconium still did not pass, and a roentgen examination showed gas-filled bowel terminating in a blind pouch about 3 cm. proximal to the anal marker placed in the dimple, and 1.5 cm. anterior to the sacrum. Instillation of iodized oil through the perforated anal site showed the lower pouch to be 3.5 to 4 cm. in depth, extending to the gas-filled loop, adjacent to the sacrum, and having a filiform fistula passing to the neural canal between the fourth and fifth sacral segments. Meconium was found in the urine, indicating a fistula between the sigmoid and urinary system. Despite a cecostomy for relief of intestinal obstruction, the patient died. Autopsy confirmed the above findings and established the sigmoid fistula to be between the blind pouch and the prostatic urethra.

Causes of death in 5 additional patients, all with Type 3 anomalies, included intestinal obstruction, urinary tract infection, and congenital heart defect. Of the 6 Type 3 patients still living, treatment had been completed in 3, with good results in 2 and fair anal function in the third. The other 3, at the time of the report, still needed additional plastic perineal repair. The results were good or fair in all Type 1 cases.

LESTER M. J. FREEDMAN, M.D.

**Hepatoma of the Liver with Metastasis to Bone Occurring in a Patient Known to Have Had Advanced Cirrhosis Eight Years Previously.** Maurice Menck and Harold A. Hanno. *Gastroenterology* 3: 206-213, September 1944.

In 1934, a 50-year-old laborer was admitted to the Graduate Hospital, University of Pennsylvania, with an intractable duodenal ulcer. Because of lack of response to an adequate medical regimen, subtotal gastrectomy was advised. At operation, however, a small hobnail liver was found and a gastro-enterostomy was performed. At this time, liver-function tests revealed no evidences of hepatic dysfunction except for slight dye retention with the 5-mg. dose of bromsulphalein,

a urobilinogenuria of 1:80, and slight hypoproteinemia. Clinically the patient manifested none of the findings usually associated with portal cirrhosis. He returned to the hospital eight years later with jaundice, anasarca, and a large mass in the right upper quadrant of the abdomen. A clinical diagnosis of hepatoma of the liver was then made. This was confirmed at autopsy, and portal cirrhosis and metastases in the ribs and lung were found.

The absence of abnormalities in a number of tests of liver function and lack of any of the clinical features commonly encountered in cirrhosis at a time when the liver of this patient was frankly cirrhotic emphasize the fact that any given test of liver function may be negative despite the presence of a cirrhosis. This case shows that a cirrhotic liver may well antedate by a considerable number of years the manifestations of clinical portal cirrhosis. It illustrates, also, the association of hepatoma and cirrhosis of the liver and conclusively shows, in this one instance at least, that the cirrhosis preceded the hepatoma by several years. From recent reports it is apparent that, although osseous metastases from hepatomas are not common, they occur less rarely than is ordinarily supposed.

**Papilloma of the Gall Bladder.** William Greenwald. *Surgery* 16: 370-376, September 1944.

There is considerable diversity of opinion regarding the occurrence of papillomas of the gallbladder. A large number have been reported from the Mayo Clinic (Phillips: *Am. J. Surg.* 21: 38, 1933), whereas Kerr and Lendrum (*Brit. J. Surg.* 23: 615, 1936) found but 21 "authentic" examples in the literature up to 1936. The author reports 2 cases.

**Case 1:** A 46-year-old white woman complained of pain in the right upper quadrant one-half to four hours after meals, particularly after ingestion of fried or fatty foods. Six months before admission she had a severe attack of colicky pain in the right upper quadrant, radiating around the abdomen and back toward the right scapula, accompanied by nausea and vomiting. The blood count was not significantly abnormal. Gastric analysis showed a low hydrochloric acid. The gallbladder was well visualized roentgenographically and of normal size and shape. Emptying was slightly delayed. A small negative shadow was thought to represent a stone or papilloma but, because of its consistently fixed position in all views, the latter possibility was considered more likely.

The gallbladder, though apparently normal, was removed and, when opened, showed a papilloma the size of a split pea. Microscopically this proved to be an adenomatous papilloma. Recovery was complete.

**Case 2:** A 36-year-old white woman complained of slight discomfort after eating. One week previously, she had experienced a severe attack of colic in the right hypochondrium, accompanied by nausea and vomiting. Routine physical and laboratory examinations revealed nothing of significance. X-ray studies showed a small negative shadow in a well filled gallbladder, slightly larger than normal. The gallbladder emptied fairly well after the fatty meal, and the negative shadow persisted. Because of its relatively fixed position in all views, a diagnosis of papilloma was made. As in the first case, the gallbladder appeared normal at operation but was removed because of the roentgenographic findings and previous history of colic. A small papil-

of argentaffin tumor is of great importance, since the proportion of cases in which the tumor is non-cancerous is high and surgical treatment offers a good prognosis.

**Leiomyoma of the Jejunum: Intermittent Melena of Fourteen Years Duration, and Fatal Hemorrhage.** Harold A. Hanno and Maurice Mensh. *Ann. Surg.* 120: 199-206, August 1944.

A case of leiomyoma of the jejunum, with twenty known episodes of melena over a fourteen-year period and a fatal termination, is reported. Repeated roentgen examinations, including progress-meal studies, revealed no lesion in the upper gastro-intestinal tract or colon. A gastro-enterostomy was performed three years after the onset of symptoms, although at operation no ulcer of the stomach or duodenum could be found. Several gastroscopic examinations in the period following gastro-enterostomy showed no evidence of bleeding points or ulceration either in the body of the stomach or the well visualized stoma. A tumor of the jejunum was found at autopsy.

This case emphasizes the fact that much too frequently the presence of a neoplasm of the intestine is not suspected. This possibility should be considered in any patient who has repeated episodes of melena in the absence of a demonstrable lesion in the upper gastro-intestinal tract or colon, and in any patient with recurrent partial or complete obstruction of the small bowel.

Roentgenography is of assistance in the diagnosis in many but not all cases of tumor of the small bowel. There are several reasons for the failure of this procedure. Perhaps the most important of these is that the clinician fails to suspect a tumor and, as a consequence, the roentgenologist, not being forewarned, does not look for such a lesion with sufficient care or persistence. Secondly, subserosal tumors, which accounted for two-thirds of the cases of myoma in one series, are unlikely to produce a marked subtraction defect in the silhouette of the barium-filled small bowel. Thirdly, due to the extensive overlapping of small bowel shadows, a defect may easily be overlooked. Repeated progress-meal studies and, in some cases, the introduction of barium directly into the jejunum through a tube are prerequisites for adequate demonstration of small intestinal neoplasms. If obstruction is present, plain films of the abdomen will reveal the usual roentgen evidences of dynamic ileus, and in those cases of colonic involvement by an intussuscepting mass in the small intestine, barium enema studies are of value.

**Diverticula and Duplications of the Intestinal Tract.** J. L. Bremer. *Arch. Path.* 38: 132-140, September 1944.

While this paper is not written from the point of view of the radiologist, he will find its discussion of those anomalies of the intestinal tract known as "duplications" or "reduplications," "enteric" or "enterogenic cysts," "ileum duplex," and "giant diverticula" of interest. The author's conclusions constitute a good summary:

"The group of anomalies comprising the enterogenous cysts, intestinal duplications and the like is divisible into two smaller classes on the basis of embryologic origin. Most of the spherical cysts are derived from true diverticula, which are frequently found projecting from the ventral or antimesenteric

surface of the tube in embryos of the eighth or ninth week and are normally absorbed later. Abnormally they continue to grow: If restricted by the intestinal muscle, they bulge within the lumen, but if they pierce the muscle layers, outward expansion is not limited and they may become large cysts attached to the intestine. Their wall is necessarily thinner than the gut wall.

"A few of the spherical and most of the tubular structures represent true duplication, originating by an abnormal persistence of the vacuoles normally present among the massed cells of the 'solid stage' of the intestine, a phenomenon of growth in embryos of the sixth or seventh week. By the confluence of a chain of vacuoles a new channel is formed, parallel to the original lumen, and becomes separated from the latter by a union of the intestinal layers between the two. Since the duplication develops within the intestine, the outer wall of the duplicate portion always contains all of the tissue layers of the intestine. The duplicate lumen usually lies between the leaves of the mesentery but may be entirely separated, with a mesentery derived by the splitting of the original. It may open into the main lumen at one or more places, or become a closed cyst. Theoretically, three or more channels are possible, the main lumen and two or more confluent chains of vacuoles.

"The duplicate structures assume many forms . . . and are often associated with other anomalies. In the tubular portions the mucosa tends to resemble that of the parent tube, but in bulbous or cystic portions it changes to the gastric type. Great internal pressure may destroy mucosa of any type."

**Congenital Anomalies of the Lower Part of the Rectum: Analysis of Sixteen Cases.** Madison J. Lee, Jr. *Am. J. Dis. Child.* 68: 182-189, September 1944.

Congenital malformations of the anus and rectum are uncommon, occurring in 1 out of 5,000 infants. They result from imperfect separation or obliteration of cavities and failure of proper rupture of the anal membrane. This is indicated by a review of the embryology of the five- to eight-week fetus from the formation of the urogenital sinus and cloaca to its separation into the urogenital system and rectum and concurrent dimpling of the proctoderm with formation and eventual dissolution of the anal membrane. It is mentioned incidentally that the external anal sphincter develops from the local mesenchyme, independent of the lower bowel segment, and may be present notwithstanding local anomalies.

The author reports in adequate detail 16 cases of anorectal malformations collected from three hospitals over a four-year period. He has used the classification of Ladd and Gross (*Am. J. Surg.* 23: 167, 1934), which is as follows:

- Type 1.* Incomplete rupture of the anal membrane or stenosis at a point 1 to 4 cm. above the anus.
- Type 2.* Imperforate anus due to a persistent anal membrane.
- Type 3.* Imperforate anus with the rectal pouch separated from the anal membrane. The rectal pouch is a closed sac.
- Type 4.* Normal anus and anal pouch with a blind rectal pouch. There is either membranous obstruction or considerable separation between the two pouches.

The oil did not enter the axillary pouches as it does normally.

The observations indicated that ruptured disks protruding into the lower cervical canal may result in either no obstruction or in partial or complete block. When there was little or no block, the myelogram resembled those for intramedullary cord tumors, showing a cap-like defect. With a herniated disk, however, the cap-like defect is transitory and, unless watched for carefully, may be overlooked. In the presence of intramedullary cord tumors the defect is permanent and lipiodol is seen in the axillary pouches. When complete block occurs, it is difficult to rule out an extramedullary tumor. Such tumors, however, are often associated with changes in the adjacent osseous and soft-tissue structures.

The distribution of pain in the authors' cases was bizarre. There was little pain referable to the cervical area. One patient had pain at the base of the neck. Another had pain in the lower lumbar region and 3 had no back pain. Weakness, paresthesias and pain in both upper limbs were observed in one patient. Right arm symptoms were present in 2 patients and one had sensory disturbances in the left arm. Lower extremity pain, weakness, and paresthesias occurred in 4 patients. The symptomatology in all 5 cases reported here was referable to the dorsal funiculi, the pyramidal tracts, and the lateral and ventral spinothalamic tracts. Root pain was observed, but was not a predominating symptom.

CLARENCE E. WEAVER, M.D.

**Adolescent Kyphosis.** T. J. B. A. MacGowan. *Lancet* 1: 211-214, Feb. 12, 1944.

If the vertebral nucleus is destroyed before ossification of the vertebral body is complete, owing to failure of the cartilaginous disk to retain the nucleus or to softening of the vertebral body, the axis of weight-bearing is transferred anteriorly and the axis of motion posteriorly. If the patient is adolescent, the epiphysis will be subject to trauma. Abnormal ossification follows, leading, after a period of increased growth, to premature closure of the epiphysis, failure of anterior vertebral ossification, and wedge formation of the vertebral bodies. The mobile stage of kyphosis merges into the fixed, and thence into the fixed arthritic stage.

In the early mobile stage, the deformity, being correctable, is mainly a soft-tissue defect. The spine is held at the limit of flexion, but extension is still possible. In the late mobile stage, this extension is less and bony changes occur without much alteration in the roentgen picture. Probably at this stage nuclear prolapses have followed nuclear displacement, under continued flexion strain. If the epiphysis appears, it will be now subject to a trauma, growth of bone will be disordered, and by the early rigid stage, roentgen changes can be seen in an area of the vertebral body which, in the adult, would be in the region of the junction of the anterior third and posterior two-thirds of the vertebral end plates. In the late rigid stage, wedge-shaped bodies are the rule, owing to the continued growth of the body centers and a process of modeling which flattens out the step between the arrested end plates and the projecting area of bone formed by the center.

Nuclear prolapses, to be visible roentgenologically, must be surrounded by a shell of compact bone. They are therefore seen at a late stage and always in the

area of the nucleus, or posterior to that region. In the late arthritic stage the ordinary degenerative changes include thinning of and ossification or calcification in the intervertebral disks, formation of anterior vertebral spurs, ossification in the posterior ligaments, and ossification or calcification in the soft tissues in or around the vertebral disk.

The x-ray appearance of the normal spine at various ages is also discussed.

**Roentgenographic Diagnosis of the Small Central Protruded Intervertebral Disc, Including a Discussion of the Use of Pantopaque as a Myelographic Medium.** Benjamin Copleman. *Am. J. Roentgenol.* 52: 245-252, September 1944.

There is a small group of patients with disk protrusions in which the characteristic lateral defect is not found during the course of the usual myelographic examination. The author injects 3 c.c. of pantopaque firmly and steadily. After the injection, the patient is placed prone and the lumbar puncture needle left in place. The table is then tilted so that the opaque fluid descends the spinal canal slowly and the advancing margin of the column is watched for slight deformities. "Spot" roentgenograms are made. The column is also followed as it ascends the spinal canal, and oblique observations and "spot" roentgenograms are made. Oblique views have been found more helpful than lateral views. After the examination the oil is aspirated.

Five cases are reported in which a small central protruded intervertebral disk was demonstrated by myelographic study and was found at subsequent operation. In 4 of these cases the outline of the oil column was practically normal when it completely bridged the level of the protrusion, aside from asymmetry of the nerve exits. In one case there was a slight deformity, which in itself was insufficient to warrant a positive diagnosis. Detection was made by careful observation of the slowly advancing edge of the pantopaque column to outline a small herniation. There was no defect of the nerve sleeves.

The myelographic examination is greatly facilitated by the use of pantopaque, a new medium developed especially for this purpose. It is of low viscosity, unproductive of reactions, tends to remain homogeneous, and is not excessively opaque.

CLARENCE E. WEAVER, M.D.

**Low Back Pain: Subluxations of Apophyseal Joints and Fractures of Articular Facets.** Wendell G. Scott. *U. S. Nav. M. Bull.* 43: 234-240, August 1944.

In reviewing the records at a large Naval Air center, the author found examination of the lower spine for low back pain to be the third most frequent roentgenologic procedure. The conditions that are most difficult to diagnose make up a small but significant group including subluxations of the apophyseal joints and fractures of the articular facets.

Routine examination of the lower spine calls for four projections; anteroposterior, lateral, and right and left oblique. Some suggestions are offered about taking the oblique films: (1) Allow sufficient leeway in the angle at which the side of the body is raised, because of the variation in the obliquity of the articular facets among different patients and between vertebrae in the same person. The angle ranges from 30 to 45°.

irreducible displacement, operative removal of the displaced fragment is advisable before reactive hypertrophic changes take place.

Proximal pole fractures were found to be far more infrequent than waist fractures and required a longer period for union, an average of 20 weeks as compared to 12.5 weeks. In this group vascular disturbance, delayed union, and non-union were more common. Avascular necrosis only delays union; it is not necessarily a precursor of non-union.

Seventy cases in this series were not diagnosed until at least two months after the injury and in these the results of treatment were frequently disappointing. No fracture united with immobilization only if the diagnosis was made later than nine months after the injury. These fractures showed sclerosis of the margins.

The authors believe there is only one indication for bone grafting and that is non-union, as shown by sclerosis of the fracture margins. In cases with union following operation the minimum period of postoperative immobilization was fourteen weeks.

There were 11 cases of fracture dislocation and in each the proximal fragment retained its relationship with the semilunar and the distal fragment with the capitate.

In summary, the authors re-emphasize the fact that the primary problem is early diagnosis. Roentgenographic examination should be made during the course of treatment, with the surgeon handling the wrist while it is out of the plaster. How to obtain union consistently in fractures with a late diagnosis is an unsolved problem. Those with degenerative arthritis must be treated as arthritis problems. The period required for healing any fractured scaphoid may be very long.

CHARLES R. PERRYMAN, M.D.

**Fractures of the Carpal Navicular.** Herbert E. Hipps. U. S. Nav. Med. Bull. 43: 467-476, September 1944.

The author reviews 37 cases of fracture of the carpal scaphoid. Fresh fractures may not at first be visible on the ordinary flat-hand anteroposterior or lateral film, but if tenderness on motion persists at the end of three weeks, further roentgen study will usually reveal the diagnosis, since enough absorption will have taken place to make the fracture line clearly discernible. In ununited fractures the fracture line is indicated by a zone of marginal absorption in one or both fragments. In early non-union this may be the only finding, but in a later stage marginal sclerosis will be apparent and cavitation will occur in bone adjacent to the fracture line or at some distance.

The present series included 26 fresh fractures and 11 cases of non-union. The fresh fractures, with 3 exceptions, and selected cases of non-union were treated by complete immobilization in a non-padded plaster cast, so applied that motion of the fingers was not limited. In the 23 fresh fractures thus treated firm union occurred in an average period of eighty-seven days. In the other 3, results were poor. In one of these no cast was applied; in another the cast was padded, and in the third the plaster was removed after thirty days. Union was also obtained in 5 of the 6 cases of ununited fracture in which the non-padded cast was used.

In ununited fractures roentgen examination was found to offer certain criteria upon which a choice of treatment could be based. Union following immobili-

zation by the method described could be expected under the following conditions: a narrow fracture line; a good blood supply to both fragments, indicated by their equal density; absorption and sclerosis on both sides of the fracture line; slight or no marginal sclerosis. Open operation with freshening of the fracture surfaces and drilling of the fragments followed by immobilization is indicated in the presence of a narrow fracture line with marginal sclerosis and avascularity of one fragment. A bone graft operation (plus prolonged fixation) becomes necessary if there is a wide fracture line.

STANLEY H. MACHT, M.D.

**Perilunar Dislocation of the Carpal Bones and Dislocation of the Lunate Bone.** W. Russell MacAusland. Surg., Gynec. & Obst. 79: 256-266, September 1944.

The author recognizes two types of dislocation involving the lunate or semilunar bone: the perilunar dislocation, in which there is volar or dorsal luxation of the carpal bones around the lunate, and the dislocation of the lunate bone itself either dorsalward or volarward. The former may be accompanied by a fracture of the navicular bone or of the radial or ulnar styloid process. These dislocations are not of frequent occurrence, the author having encountered only 24 cases in twenty-seven years of orthopedic practice. In 16 cases there were associated fractures.

Diagnosis requires a true lateral, as well as an anteroposterior roentgenogram of the wrist. Stereoscopic views give the most accurate picture.

The greatest difficulty in treating these cases is early recognition. A fresh dislocation is considered one that is less than two weeks old, and in such cases reduction can usually be accomplished by conservative measures, whereas later reduction even by operative intervention may be too traumatic to be feasible. Untreated and inadequately treated injuries result in impaired function due to damage to soft tissues and tendons.

Open replacement is indicated in cases of more than two weeks' standing or in a fresh case associated with considerable damage to the joint structures or to the median nerve, where manipulative replacement would cause further trauma. It is also recommended in uncomplicated dislocation of the lunate bone when manipulation fails or when the case is treated within six weeks of injury. Dislocations of more than six weeks' duration are best treated by excision, which yields, on the whole, a useful wrist and joint. Operative reduction is more likely to succeed in incomplete dislocation than in complete dislocation, since in the former there are sufficient ligamentous attachments to ensure adequate blood supply to the lunate.

Perilunar dislocation in elderly patients with arthritic joints, when complicated by excessive damage to the tissue structure and a disturbance of circulation, are best treated by an arthrodesis of the lunate, navicular, and capitate bones.

DAVID KIRSH, M.D.

**Paget's Disease: Its Pathologic Physiology and the Importance of This in the Complications Arising from Fracture and Immobilization.** Edward C. Reifstein, Jr., and Fuller Albright. New England J. Med. 231: 343-355, Sept. 7, 1944.

Following a discussion of normal bone physiology and histology, the authors review the morbid anatomy of Paget's disease. This condition is defined as a localized bone disease, since one can usually find a sharp



line of demarcation between normal and diseased bone. Localization is offered as evidence against a metabolic or endocrine etiology.

Paget's disease has much in common with the actual bone lesion of osteitis fibrosa generalisata. In both conditions there are extreme vascularity, marked fibrosis, and equal bone destruction and bone repair. The architecture of the two conditions differs. In Paget's disease the trabeculae start nowhere and end nowhere, and the cement lines within the trabeculae show a bizarre arrangement.

To determine whether bone destruction or bone production is the initial process, one must examine the advancing edge of the lesion. This shows that destruction precedes production. Microscopically numerous osteoclasts are seen in the advancing part of the lesion but no bone formation or osteoblasts.

Two interesting case histories are presented. The first patient was a 58-year-old male with Paget's disease, who fractured the neck of his right femur for the third time. He consumed large quantities of milk even while immobilized for treatment. After two weeks he complained of anorexia, headache, and a peculiar sensation of dryness in his throat; then epigastric distress, nausea, and occasional vomiting began. The specific gravity of the urine became fixed at 1.008 and the blood calcium was found to be 13.4 mg., serum phosphorus 4.2 mg., and serum phosphatase 4.3. With elimination of milk from the diet and increase of other fluids, the patient became much better and the urine and blood findings returned to normal. The second case was similar to the first.

The important feature of these cases is the danger of a chemical death when a patient with Paget's disease is immobilized. The peculiar sensation of dryness in the throat, with nausea and vomiting, seems to be related to hypercalcemia.

JOHN B. McANENY, M.D.

**Polyostotic Fibrous Dysplasia.** D. K. O'Donovan, F. Duff, T. D. O'Farrell, and John McGrath. *Irish J. M. Sc.*, September 1944, pp. 498-504.

A case of polyostotic fibrous dysplasia in a 4 1/2-year-old girl is recorded. Though fairly typical, this case presented some unusual features, as retarded mental development, extensive lesions in the bones, predominance of cartilage in biopsy specimens of bone, and anemia with nucleated red cells in the peripheral blood. All the bones of the body showed slight decalcification and a lack of normal trabeculation, even in the absence of cyst-like formation. The differential diagnosis of the disease is discussed; roentgenograms are reproduced.

**Sarcoidosis. Report of a Case.** John A. Boone and Ralph R. Coleman. *South. M. J.* 37: 477-481, September 1944.

A case of sarcoidosis in a 40-year-old Negro is presented. In addition to the typical lesions of the nose, ears, fingers, toes, and lymph nodes, this patient showed two other features of the disease: elevated plasma protein and eosinophilia. Although he had been exposed repeatedly to active tuberculosis, he gave a negative tuberculin reaction, and a thorough search of the lesions for tubercle bacilli was fruitless. Roentgenograms of the hands and feet revealed multiple involvement of the metacarpals, metatarsals, and phalanges, the lesions appearing as distinct coarsening of the trabeculae, with multiple cystic areas. In only one or two places was

there any distinct bulging of the cortex. Some small cystic areas were seen in the carpal bones, none in the tarsal bones. Photographs and roentgenograms showing the lesions of the hands and feet are reproduced. X-ray examination of the chest, skull, long bones, and pelvis was negative.

**Multiple Diffuse Fibrosarcoma of Bone.** Paul E. Steiner. *Am. J. Path.* 20: 877-893, September 1944.

A case of multiple diffuse fibrosarcoma of the bone in a 43-year-old male is reported. This tumor was studied by a number of experienced American and European bone pathologists, none of whom had ever seen a similar growth.

Except for dryness and scaling of the skin of the extremities, the patient was well until 1934, when he began to have pain in his back. There was no history of trauma. He continued to work as a coal passer on the railroad until December 1935, when the pain became too severe for him to continue. He entered the hospital on Jan. 16, 1936. The pain was chiefly lumbar, continuous, did not radiate, and was worse at night and on motion. The back appeared normal. The left leg was shorter than the right and the pelvis was tilted. The left knee jerk was increased. The left testicle was atrophic. An ichthyosis of the skin of the arms and back was present. A lateral roentgenogram of the lumbar vertebrae showed no evidence of fracture, dislocation, demineralization, or other bone abnormality. Fluoroscopic examination of the chest was normal. Studies of the alimentary tract were negative except for ptosis of the transverse colon. Laboratory findings were normal. The diagnosis at this time was possible beginning of Paget's disease.

The patient continued to have severe pain in the lower dorsal and lumbar regions, unrelieved by removal of his teeth, traction, or by drugs. The dorsal and lumbar spine became fixed and there was a kyphos in the region of the 8th dorsal vertebra. On July 29, roentgen studies showed "a destructive process involving the bodies of the 4th, 5th, 6th, and 9th thoracic vertebrae and the 1st lumbar vertebral body; also the transverse processes; the 12th rib on the left side and the 11th right rib, suggestive of malignancy." There was a mottled appearance of the pelvis suggestive of atrophic change.

In August, two small nodules appeared on the ribs, and in September non-traumatic fractures of the 6th, 7th, and 8th ribs were observed. Numbness to the level of the knees also developed in September. The patient had a severe progressive anemia, poor appetite, and frequent emeses. He died Oct. 30, 1936. He had received no x-ray or radium therapy. The final clinical impression was malignant tumor metastatic to bone, with the primary site undetermined. Autopsy findings are given in detail and postmortem roentgenograms are reproduced.

This case was one of osteolytic fibrosarcoma of bone in which the lesions appeared at approximately the same time in many bones, and in which the tumors, although highly infiltrative, retained the normal configuration of the bones. Nowhere was there any considerable mass or enlargement suggestive of a primary site of origin. The distribution and extent of the sarcoma were those of the hemopoietic and reticulo-endothelial areas in the skeleton. There were small metastases in many viscera. Two views about the



nature of this tumor present themselves. One is that it represents widespread sarcomatous change in Paget's disease. The other is that it is a peculiar fibrosarcoma probably arising from the medulla of bone and possibly multicentric in origin, and thus related to the myelomas, which it resembled in its distribution and behavior. The author favors the latter theory.

**Ossifying Fibroma of the Superior Maxilla.** H. James Hara. *Arch. Otolaryng.* 40: 180-188, September 1944.

Three cases of ossifying fibroma of the superior maxilla, occurring in women aged 20 and 29 and in a boy of 14, are reported. This tumor is slow growing and usually unilateral. The site may be in the antero-lateral process, with eventual obliteration of the canine fossa and possible invasion of the adjacent portion of the malar bone. Outward expansion on the buccal surface results in a characteristic facial deformity. In other patients the tumor invades the hard palate, occasionally causing dysphagia. There is no tendency to metastasize, and malignant change has not been recorded. The teeth overlying the tumor may be healthy or they may be carious; they are usually irregular and crowded. The soft tissue over the growth is smooth and avascular, but the tumor feels hard and unyielding.

Roentgenography is a distinct aid in diagnosis. It is of assistance in distinguishing the cancerous bone-forming tumor from the non-cancerous one. The contour of the non-cancerous tumor is always smooth; the cancerous growth tends to infiltrate. Two distinct types of ossifying fibroma may be recognized roentgenologically—the circumscribed and the diffuse. The maxilla is enlarged. The cortex is thinned. There is no periosteal reaction. In all of the present series the lower half of the affected maxillary sinus appeared diffusely clouded. A small area of rarefaction above the site of the tumor suggested the presence of air. The mucosal lining was intact. According to Worth (*Brit. J. Radiol.* 10: 223, 1937), the growth occurring in younger patients casts a homogeneous but soft shadow on the film, presenting a stippled appearance not unlike that of the rind of an orange; in older patients, a dense ground-glass shadow, appearing much harder and structureless.

Two of the tumors in this series were well circumscribed; the third was diffuse. The circumscribed tumors were completely resected. The diffuse tumor was curetted sufficiently to give its bony bed a normal contour. No attempts were made to remove the portion which infiltrated the dental roots.

**Capillary Hemangioma of Bone (Case Report).** Mary S. Sherman. *Arch. Path.* 38: 158-161, September 1944.

Approximately 60 cases of hemangioma of the bone, not all well confirmed, have been recorded. In two-thirds of these cases the tumor was located either in the spine or in the skull; in one-fourth, in the long bones; in 2 cases, in the pelvis; in 2, in the tarsal bones; in 1, in the scapula. The pathologic observations in almost all of these cases are similar, being those of typical cavernous hemangioma. Among all the varied reports, there are only 4 cases in which the hemangioma was thought to be of the capillary type. A fifth case of this type is presented.

A one-month-old girl was first brought to the clinic because of a swelling of the left knee, which had been observed since a few days after birth. Examination showed the circumference of the left knee to be 1 cm. greater than the right. A roentgenogram at eight weeks revealed no lesion of bone but a definite soft-tissue swelling. The swelling gradually decreased, and by the time the child was five months old, there was "only a slight dimpling at the site of the former sclerema." When the patient was eighteen months old she was brought back because she "slapped" her left foot as she walked. The left knee was then 2 cm. greater in circumference and the extremity 1 cm. longer than the right. Five months later the child complained of occasional pain in the knee, and a slight flexion contracture developed. The relative dimensions of the extremities had not changed and there was no abnormality on auscultation over the femoral vessels, but x-ray examination disclosed an area of radiolucency in the anterior portion of the lower part of the femur and periosteal elevation for about 6 cm. up from the epiphysial line.

When the patient was two years and four months old, more sclerosis and more periosteal new bone were visible on the roentgenogram. With a preoperative diagnosis of osteomyelitis, the lesion was explored. Organized periosteal new bone was encountered for some 5 cm. up from the epiphysal plate. The cortex was thickened over a slightly greater area, and the medullary cavity was full of sclerotic cancellous bone. As much of this as could be removed without danger of predisposing to fracture or to arrest of growth was curetted out. Anteriorly several pockets of fibrous tissue were removed. No pus was found, and the wound healed by primary intention. Sections of the material removed showed the lesion to have been a capillary hemangioma.

Eighteen months after operation, the patient was asymptomatic and the roentgenogram showed the defect in the femur to be healed. Six months later she had a brief return of pain and tenderness, subsiding spontaneously and unaccompanied by physical or roentgenographic changes. In July 1944, four and one-half years after operation, the patient had been completely free of pain for twenty-three months. There was still 1.5 cm. difference in the length of the legs, due to overgrowth of the left femur.

The histologic picture, the history of symptoms since birth, the relief of symptoms by operation in which the lesion was incompletely excised, and the fact that there was no recurrence or spread confirm the impression of a congenital capillary hemangioma, primary in the lower part of the femur, undergoing fibrous regression or "sclerosis."

## GYNECOLOGY AND OBSTETRICS

**Hysterosalpingography, a Routine Aid in Gynecological Diagnosis.** Phineas Bernstein. *Am. J. Obst. & Gynec.* 48: 189-199, August 1944.

For visualization of the female genital tract, the use of a new opaque medium, Viscorayopake, is recommended. Non-toxic, quickly absorbed, chemically stable, and amply viscous, it is easily administered and does not gel or crystallize at room temperature. The technic is simple and safe, and undesirable side effects are minimal.

The patient is given 2 drams of licorice powder the

night before and an enema on the morning of the test. A preliminary bimanual examination is performed to determine the cervico-uterine angle (for direction of the canal) and the fundal size (for estimation of its capacity). The medium is introduced by means of a 20-c.c. syringe fitted by a Luer metal tip to a uterine stem cannula with perforated end, as used in the Rubin insufflation test, or to a Colvin stainless steel screw-tip cannula. Upward pressure of the syringe piston displaces air from the syringe and its contained opaque fluid. If the medium injected into the uterine cavity contains air bubbles, errors in diagnosis are prone to occur. The cannula is then cautiously inserted through the external os, following the line of the cervico-uterine axis, until the perforated tip lies within the cavity.

For roentgenography the factors used ordinarily, for a 20 cm. body thickness, are: 50 ma., 58 primary volts, a two-second exposure, and a focal plate distance 30 to 36 in. A scout film is first taken. This often reveals calcified lymph nodes, phleboliths, or unabsorbed lipiodol used in previous tests, and is of value in excluding misleading shadows. After each 2 c.c. of radiopaque fluid has been injected, films are taken until 6 or 8 c.c. of Viscorayopake and four or five x-ray films have been used. The fluid contents of the uterine cavity may then be removed by withdrawing the piston.

The syringe is disconnected from the cannula, and about 10 to 15 c.c. of CO<sub>2</sub> gas, from a clean syringe, is injected into the uterine cavity. Another plate is taken while piston pressure is maintained. Hystero-aerography delineates cavity and tumor outlines by contrast of the gas with the Viscorayopake film adherent to the uterine wall.

Enlarged uterine cavities or tubal dilatations sometimes require up to 15 c.c. of opaque medium.

The alteration in size and contour of the uterine shadow indicates not only the extent and location of new growths, but also identifies the type of tumor by means of characteristic and representative patterns. Salpingography serves both to differentiate between uterine and ovarian tumors and between abdominal tumors and those of pelvic origin. It is also useful in determining the structural status of the fallopian tube in patients undergoing treatment for sterility.

Contraindications to hysterosalpingography are acute pelvic disease, gonorrhea, intrauterine or ectopic pregnancy, cervical carcinoma or infection, and epilepsy.

Thirty-eight women were examined roentgenographically in the course of sterility studies after insufflation by the Rubin technic. Infantile uterus was observed twice, as were bicornuate uterus and ovarian cyst. Eight patients had tubes which, although patent, showed marked curling, dilatation, or partial obstruction due probably to peritubal adhesions. Patency of one or both tubes was demonstrated 27 times. In 15 instances both tubes were open, but in 8 of these cases there were varying degrees of kinking and dilatation. In 12 patients only one tube was visualized as patent. Bilateral closure occurred at the fimbriated portion in 3 instances, centrally in 2, and proximally, at the uterotubal junction, in 6.

Fourteen patients were examined for other complaints than sterility. In this group were 6 fibroids, 4 ovarian tumors, 2 cases of hydrosalpinx, a uterine polyp, and a multiple carcinoma of the uterus and tube. Most of these lesions were previously diagnosed, but in each instance further information was obtained by roentgen

study. The stereoscopic technic proved valuable in determining not only the exact position but also the relative size of the tumors.

Constant x-ray evidence of tubal closure was obtained in three pregnant patients and may indicate that a uterotubal sphincter spasm occurs physiologically in the gestational state.

The findings are statistically presented, with numerous reproductions of x-ray films. The article merits further study by those interested in employing this procedure.

STEPHEN N. TAGER, M.D.

## THE GENITO-URINARY TRACT

**Renal Calculus with Parathyroid Adenoma.** Gordon S. Foulds. *J. Urol.* 52: 180-183, September 1944.

The author reports a case of multiple renal calculi attributable to hyperparathyroidism. He impresses the reader with the importance of a more thorough study of patients with recurring kidney stones.

A 22-year-old woman was first seen in 1928 with a right ureteral stone. At frequent intervals thereafter stones were removed from both sides of the urinary tract either by manipulation or operation.

In January 1936, parathyroid adenoma was suspected, but though the blood calcium was slightly elevated, a normal blood phosphate level, the oxalate composition of the stones removed, and the lack of calcium withdrawal from the bones, as shown by x-ray, caused this diagnosis to be temporarily abandoned.

Eight years later, in December 1943, the patient was admitted to the hospital with bilateral renal calculi, bone pain, fatigue, weakness, elevated blood calcium, decreased blood phosphorus levels, and x-ray evidence of osteitis fibrosa cystica. This picture, with biopsy evidence of fibrocystic disease of the left ilium, led to a diagnosis of hyperparathyroidism and in January 1944 a parathyroid adenoma was removed. After a somewhat stormy convalescence and treatment with parathyroid hormones and calcium, the patient was discharged in March 1944. She was practically free from pain and gaining strength. No change had taken place in the bones or in the renal calculi.

N. P. SALNER, M.D.

**Extrarenal Tuberculous Lesions Associated with Renal Tuberculosis.** D. S. Cristol and L. F. Greene. *New England J. Med.* 231: 419-420, Sept. 21, 1944.

In the diagnosis of renal tuberculosis, a suspicion of the disease plays a large part, and any factor that will increase such a suspicion is welcome.

The authors have found that calcified mesenteric lymph nodes occur twice as frequently in renal tuberculosis as in a control group.

Of 81 males with renal tuberculosis, 34 (42 per cent) had genital tuberculosis, 31 had tuberculous epididymitis, and 3 tuberculous prostatitis. The presence of tuberculous epididymitis highly suggests renal tuberculosis, and in the presence of the latter disease, the genitalia of male patients should be examined for tuberculosis.

The healed or active adult type of pulmonary tuberculosis was found to occur in 34 per cent of the cases of renal tuberculosis as compared with 4 per cent in a control group. The healed childhood type of pulmonary tuberculosis occurred in 14 per cent of both the renal tuberculosis group and the control group.

JOHN B. McANENY, M.D.

**Case of Congenital Absence of a Kidney.** Gustavo Cardelle, J. García Romen, and J. García Rivera. *Bol. de la Soc. cubana de pediat.* 16: 363-367, September 1944.

A 10-year-old colored girl was brought to the hospital because of continuous fever of twenty days' duration. In a routine clinical examination, the only significant finding was a tumor-like mass in the right upper abdomen. Retrograde pyelography following the routine laboratory examination revealed no ureteral opening in the bladder on the left. Through a very small right ureteral opening a catheter was inserted and a retrograde pyelogram was obtained, demonstrating clearly the hollow portion of the right kidney. Intravenous pyelography a few days later again indicated absence of the left kidney.

It is the opinion of the authors that a solitary kidney is of relatively frequent occurrence. The ureter is usually absent, also, although it may be present in rudimentary form.

Campbell, reviewing an autopsy series, reported the absence of one kidney once in 1,610 cases; in children, the absence was a little more frequent, once in 1,575. The left kidney was found to be absent about twice as often as the right. A. MAYORAL, M.D.

**Renal Hydrocele: Subcapsular Renal Extravasation.** Louis H. Baretz. *J. Urol.* 52: 184-198, September 1944.

In this paper, the author discusses a condition which has been reported in the United States only a few times previously, namely renal hydrocele. This consists in the extravasation of urine beneath the true renal capsule, so that the kidney is almost completely enveloped by a cyst or sac lined parietally by capsule. Crabtree (*Tr. Am. A. Genito-Urin. Surgeons* 28: 9, 1935) is quoted as setting forth the following factors necessary to the condition: trauma which opens the renal pelvis or a calyx; maintenance of the opening beyond the healing period; acquired or pre-existing hydronephrosis. The author adds another, slow extravasation beneath an uninjured capsule.

Symptoms and signs are an enlarging mass in the kidney region, increasing abdominal discomfort, and decreasing urinary output. Retrograde pyelography may show passage of the opaque medium from the renal pelvis to a surrounding sac. Early operation is indicated. It is not always necessary to sacrifice the kidney.

The author reports a case presumably occurring late in the course of pregnancy. A small abdominal mass was first observed three days postpartum, though the fact that the possibility of a twin pregnancy had been entertained indicates that the mass may have been present earlier. By the fourteenth day postpartum, it was shown roentgenographically to occupy the entire left upper abdomen, extending across the mid-line to the right and displacing the stomach and intestines. It continued to increase daily in size, and pain was persistent. A diagnosis of possible polycystic kidney was made, and operation was undertaken. The mass was incised and 6,000 c.c. of cloudy, purulent urine were evacuated, and a portion of the sac wall was removed for microscopic study. The diagnosis was subcapsular extravasation or renal hydrocele. A left pyelogram made twenty-three days after operation showed an elongation of the superior calyx and distortion of its

minor calices. The dye was seen to extravasate through the superior calyx and pool in a large cavity which was interpreted as a cystic space or locule where the capsule had not completely separated from the kidney. This was apparently filled with urine and pus. The kidney wound was opened and the locule drained, following which recovery was complete.

On questioning, the patient recalled a slight blow to the left side about a week before hospital admission. This had caused momentary pain but had promptly been forgotten. The author believes that complete subcapsular extravasation did not occur immediately, as the pregnant uterus, by direct pressure upon the kidney, may have acted by tamponage to prevent urinary leakage. Following delivery, this pressure was relieved and the tear from calyx to capsule allowed free extravasation. The pre-existence of a dilatation of the renal pelvis and calices is assumed, as this is of common occurrence in the later months of pregnancy. This, followed by trauma to produce the required slow leakage, completed the necessary factors for renal hydrocele. EDWIN L. LAME, M.D.

**Non-Fibrous Vesico-Ureteral Obstruction.** James F. McCahey and John S. Fetter. *J. Urol.* 52: 216-223, September 1944.

Obstruction in the intramural portion of the ureter in the absence of fibrous constriction is not generally admitted at present. Hunner (in Cabot's *Modern Urology*, 1924, Vol. 2, p. 255) has described ureteral stricture of large caliber, but this conception has not been favorably received by urologists. Current urologic practice is to assume that if there is no impediment to the passage of a ureteral catheter upward, there is no hindrance to the flow of urine downward. The purpose of this paper is to show that vesico-ureteral obstruction may exist without an organized stricture.

Four cases of renal colic and one of hematuria are presented. All are believed to be examples of non-fibrous vesico-ureteral obstruction. Ureteral catheterization disclosed no obstruction in these cases, but intravenous urography revealed dilatation of the ureter, or pelvis and calices, or the entire upper urinary tract. Catheterization and dilatation of the involved ureter resulted in cessation of symptoms and improvement in the roentgenographic appearance after intravenous urography. Reproductions of urograms from 4 of the cases are included.

The authors believe that diagnosis of stricture of the free portion of the ureter should not be based solely on the appearance of narrowed areas in intravenous urographic films, without a supplementary retrograde study. One of the cases is cited to demonstrate that ureteral dilatation does not necessarily mean ureteral atony. If the latter can be prevented by proper management, life may be prolonged.

The following conclusions are reached:

The fact that ureteral catheterization offers no difficulty is not proof that obstruction does not exist at the vesical end of the ureter.

Non-fibrous vesico-ureteral obstruction should be considered whenever suspicion of obstruction is justified by the urologic findings.

Continued dilatation may be necessary in some instances of vesico-ureteral obstruction.

Proper management may be not only pain-relieving but life-prolonging. CHARLES R. PERRYMAN, M.D.

**Primary Neoplasms of the Ureters: Report of Six Cases.** Roger W. Barnes and George K. Kawaichi. *Urol. & Cutan. Rev.* 48: 430-436, September 1944.

Hematuria, the most common symptom of ureteral tumor, was present in all 6 cases of ureteral neoplasm reported by the authors. Pain was the second most common symptom and was present in 4 cases. One patient had a severe renal infection proximal to the tumor; one had burning on urination, and another loss of weight.

Cystoscopic examination revealed no renal function in 5 cases and reduced renal function in 1. Obstruction to the ureteral catheter at the tumor level was present in 5 cases. Hydronephrosis and hydroureter were invariably present, but in varying degrees. A ureteral filling defect was demonstrated in 4 cases. In another case, diagnosis was not made until four years following a nephrectomy, when cystoscopy revealed a tumor protruding from the ureteral orifice. Diagnosis in a sixth case was based on evidence of ureteral obstruction at cystoscopy and irregularity of the lower edge with no evidence of dye proximal to the tumor in the uretero-gram.

Ureteral tumors should be considered in all patients with hematuria. Diagnosis is contingent on good pyelo-ureterograms, and demonstration of the entire ureter is essential. Filling defects due to tumors of the ureter show encroachment upon the lumen, with shaggy, irregular margins. Extraureteral pressure defects are more likely to be feather-edged, and ureteral strictures are conical. A filling defect over the promontorium may be due to incomplete distention of the ureters and is the result of pressure by the bony prominence.

Treatment is one-stage combined nephro-ureterectomy. The authors believe that even benign lesions are potentially malignant and should be treated as such. Six cases are reported in detail, with excellent reproductions of the pyelo-ureterograms.

MAURICE D. SACHS, M.D.

## THE BLOOD VESSELS

**Aneurysm of the Renal Artery—True and False— with Special Reference to Preoperative Diagnosis.** Joseph A. Lazarus and Morris S. Marks. *J. Urol.* 52: 199-215, September 1944.

The authors present a case of aneurysm of the renal artery diagnosed preoperatively and summarize 74 previously reported cases, listing for each case the sex, age, location, history, symptoms, signs, treatment, results, and operative or autopsy findings. Etiological factors include trauma (in 34.7 per cent of the cases), severe debilitating infections which may weaken the walls of the arteries, and atherosclerosis, which was generalized in only 10 of the cases. Syphilis was present in only 3 cases.

Aneurysms are of the true or false type. A true aneurysm is a saccular dilatation of an artery containing all elements of the arterial wall. A false aneurysm is a saccular dilatation due to trauma resulting in complete disruption of continuity of the arterial wall, either in part or in its entirety, in which the limiting wall from without inward consists of adventitia, laminated blood clot, and endothelium, the last being an ingrowth from the injured artery. Mild trauma may contuse an arterial wall but not break its continuity. Weeks or months later the area will stretch or bulge,

producing a sacciform type of arterial aneurysm, or the wall may rupture and form a false aneurysm.

Symptoms depend upon the size of the aneurysm, its location, and whether or not rupture has occurred. Small aneurysms may be symptomless, while larger aneurysms produce symptoms, the most common of which is pain in the loin. There was a palpable mass present in 30 per cent of the cases. On x-ray examination, an opaque ring shadow with a dense periphery in the region of the renal pelvis is suggestive but not pathognomonic. Dos Santos, by injecting 15-20 c.c. of a 10 per cent sodium iodide solution directly into the aorta, claims to have obtained characteristic arteriograms in cases of suspected aneurysm of the renal artery.

Treatment consists of immediate nephrectomy with ligation of the renal artery proximal to the point of origin of the aneurysm.

The aneurysm in the authors' case was associated with calculous pyonephrosis, and a correct preoperative diagnosis was made by finding the typical ring shadow on the x-ray film in the region of the renal pelvis. Owing to the location of the aneurysm, the lesion was missed at operation but was clearly disclosed on pathological examination of the extirpated kidney.

DAVID KIRSH, M.D.

**Roentgenologic Observations in Mesenteric Thrombosis.** Richard A. Rendieh and Leo A. Harrington. *Am. J. Roentgenol.* 52: 317-322, September 1944.

Three proved cases of mesenteric thrombosis are reported, in which the most striking roentgen finding was localized distention of the intestine simulating a mechanical obstruction but having a distribution which corresponded to that of the superior mesenteric artery, with an abrupt demarcation of the distended intestine near the splenic flexure of the colon. In one case a barium enema passed freely through the distended intestine showing that no mechanical obstruction was present. One patient died. The other two made a complete recovery after bowel resection.

The general causes of mesenteric thrombosis have been classified as cardiovascular, infectious, mechanical, and traumatic. Occlusion of the superior mesenteric artery is said to be forty times more frequent than blocking of the inferior mesenteric artery. Abdominal distention is a common feature. A review of the literature reveals that roentgen examination of the abdomen in this condition is infrequent. The possible diagnosis of thrombosis of the superior mesenteric vessels should be among those considered when the plain roentgenogram of the abdomen discloses bowel dilated down to the region of the splenic flexure.

Three cases are described in detail and reproductions of roentgenograms are included.

CLARENCE E. WEAVER, M.D.

## FOREIGN BODIES

**Direct Visual Guidance, Triangulation Roentgenoscopy in the Removal of Opaque Foreign Bodies.** Wendell E. Roberts. *Am. J. Roentgenol.* 52: 327-331, September 1944.

The author has designed a fluoroscope in which two roentgen tubes are mounted in parallel. One tube is so set that rays are at right angles to the table top and the other is tilted slightly so that the rays intersect

those of the first tube for triangulation roentgenoscopy. The two tubes are activated simultaneously through a foot switch, and the radiation from both is projected through the same shutter assembly. Two shadows of the opaque foreign body and the forceps or probe are thus thrown on the fluoroscopic screen. If the two instrument shadows are to the right of the foreign body shadows the instrument is too far to the right, though it may be in the proper horizontal plane. The same is true to the left. If the instrument is placed too far posteriorly (toward the table top) the two shadows of the instrument will be farther apart on the fluoroscopic screen than the two shadows of the foreign body. If the instrument is introduced too far anteriorly, the instrument is farther from the tubes than the foreign body and the two shadows of the instrument will be closer together than the shadows of the foreign body.

When the instrument is introduced into the proper plane and neither to the right nor left, the shadows of the foreign body and the instrument are in direct apposition in both images on the screen.

For foreign bodies in the eye, the patient must be placed on his side on the roentgenoscopic table. All that is necessary is to decide the nomenclature of the directions so that the surgeon will understand the directions given by the roentgenoscopist.

No measurements are needed in this method. Only a glance at the fluoroscopic screen is necessary to determine the position of the surgeon's instrument in regard to the foreign body.

Illustrations show the various positions of shadows of the foreign body and instrument with the latter placed correctly and incorrectly in relation to the former.

CLARENCE E. WEAVER, M.D.

## RADIOTHERAPY

**Hemangioma of the Adult and of the Infant Larynx. A Review of the Literature and a Report of Two Cases.** George B. Ferguson. *Arch. Otolaryng.* 40:189-195, September 1944.

One hundred and twenty-three cases of hemangioma of the larynx have been recorded in the literature. Two distinct classes have been described: the adult cases, numbering 115, and the infantile, numbering 7. One new case in each group is here reported.

Entirely different sets of symptoms characterize the infantile and adult forms of hemangioma. Because of the subglottic position of the infantile form, a slight infection of the upper respiratory tract is often sufficient to cause symptoms of respiratory distress. Wheezing and labored respiration quite similar to that seen in streptococcal laryngitis are present. The signs of acute infection, however, are not so prominent; the fever is not so high, nor are the local signs of an infection of the throat so marked. The presence of hemangiomatous involvement of other areas of the body should arouse suspicion; in 3 of the 8 reported cases there was such involvement. Lateral roentgenograms may show a discrete tumor in the subglottic larynx. In 3 of the 8 cases of infantile hemangioma the diagnosis was made only at autopsy, and in 2 additional instances autopsy confirmed the diagnosis.

In the adult type of laryngeal hemangioma the symptoms are often vague and of extremely long duration. Hoarseness, followed by cough, dyspnea, hemoptysis, and dysphagia, is common. The tumor as seen through a laryngeal mirror may be small or extremely large. It is usually described as somewhat resembling a raspberry, irregular in contour and purplish in color, though it may be red, pink, or occasionally white. Ulceration is rarely observed. The tumor is usually attached by a broad base to the underlying structures; in certain cases it may arise from a delicate pedicle.

Relief of dyspnea often becomes an urgent necessity in cases of laryngeal hemangioma of the infantile type. Tracheotomy, performed as low as possible to avoid cutting the tumor, is the best procedure in the opinion of most observers. Lateral roentgenograms of the neck, taken for soft-tissue detail, may give definite information concerning the size and extent of the tumor prior to tracheotomy. Roentgen radiation or radium, cautiously used to avoid perichondritis, usually produces a

rapid decrease in the size of the tumor. Roentgen therapy, consisting of six treatments to alternate sides of the neck, of 100 r each, with 0.4 mm. tin plus 1.0 mm. copper filtration, proved entirely satisfactory in reducing the tumor in the author's case. One year elapsed between tracheotomy and roentgen therapy. If tracheotomy has not been done as a preliminary step, the patient should be closely watched for an increase of dyspnea during the period of irradiation. He should be kept in a hospital where facilities for emergency tracheotomy are instantly available. Failure to respond to irradiation may make thyrotomy necessary.

A small tumor of the adult type may be removed through the laryngoscope by means of seizing or cutting forceps. Profuse hemorrhage is unlikely, and recurrence is rare. Fatal hemorrhage has occurred, however, and is especially to be feared when the tumor is large, particularly if it is attached by a fairly broad base. Such a tumor is best treated by coagulation with surgical diathermy or by irradiation with radon implants, radium needles, or roentgen rays. If the pedicle is easily reached through the laryngoscope, a suture may be passed through the base of the tumor, which may then be excised above this level. Larger tumors demand careful selection of approach, which may be through the mouth, by laryngofissure, or by lateral pharyngotomy.

Roentgenograms are reproduced.

**Tumors of the Urogenital Tract in the Young.** Clarence G. Bandler and Philip R. Roen. *Am. J. Surg.* 65: 306-314, September 1944.

During the past two decades, 43 cases of malignant tumor of the urogenital tract in children have been seen at the New York Post-Graduate Hospital. In this group according to the authors' tabulation, were 32 renal tumors, 3 tumors of the adrenal, 4 tumors of the bladder, and 4 tumors of the testis. [Since only 2 testicular tumors are mentioned in the text, it may be that the total should be 41 instead of 43.]

Of the 32 renal neoplasms, 31 were Wilms' tumors; the remaining tumor, diagnosed preoperatively as Wilms' tumor, in a boy of six and a half, was found on pathological examination to be a papillary carcinoma of the kidney. Wilms' tumor has been called a disease of signs rather than symptoms. The presenting complaint

in the vast majority of cases is a gradual enlargement of the abdomen. Hematuria was present in only 3 per cent of the cases in this series. The mass in most instances is smooth to palpation and has a mobility depending on its size. It characteristically grows downward, forward, and across the abdomen toward the opposite side rather than bulging in the flank as do renal tumors in the adult.

Diagnosis of Wilms' tumor can usually be made by intravenous urography. This shows not only displacement of the affected kidney and distortion of the pelvis but also delineates the opposite kidney and reveals whether it is functionally sound. In some cases, retrograde urography may be necessary. Differential diagnosis calls for consideration of suprarenal tumors, renal cysts, hydronephrosis, ovarian and hepatic tumors, splenomegaly, and retroperitoneal sarcoma. Aspiration biopsy is condemned.

Preoperative and postoperative x-ray therapy should be given. The preoperative radiation in many cases reduces the size of the mass and increases its mobility. This should be administered through several portals in fractionated doses rather than in a single massive dose, with adequate protection of vital organs. Surgical removal of the tumor is probably best performed five or six weeks after completion of the roentgen irradiation. The transperitoneal approach is favored. Postoperative irradiation should be started about one month after nephrectomy. If metastases are present or are found later, intensive irradiation should be given to the involved sites.

The prognosis in Wilms' tumor is poor. Among the 24 cases followed there were only 2 postoperative survivals at the time of the report: one for two months and the other for three years.

The 3 adrenal tumors in the authors' series were neuroblastomas. This tumor grows rapidly, protrudes posteriorly in the flank, and may require differentiation from renal tumor. Urograms show a downward displacement of the kidney, with less distortion of the pelvis than is seen with Wilms' tumor; frequently exact differentiation is difficult and the true character of the disease may be discovered only at operation. Unfortunately, in most instances, metastases are already present when the abdominal tumor first becomes apparent. In the authors' cases, metastases were widespread at the time the children were first seen. These metastatic lesions take two forms, distinguishable clinically: (1) the Pepper type, consisting in extensive metastases to the liver producing marked abdominal enlargement with pain, nausea, vomiting, and cachexia; (2) the Hutchison syndrome, characterized by early orbital and skeletal masses with consequent swelling about the bones of the skull, proptosis of the eye, and profound anemia. In either type, the course is rapidly fatal and death occurs within a few months.

Vesical tumors are unusual in children; of the 4 cases in this series, 2 were sarcomas, 1 a small papilloma, and the fourth multiple papillomas. Papillomas, although microscopic examination may show them to be benign, are potentially malignant, if only in their tendency to local recurrence.

The 2 testicular tumors occurred in boys aged one year and eight months and twelve and one-half years, respectively. The pathological diagnosis in each instance was teratoma. Palpation of a hard, enlarged scrotal organ should suggest the diagnosis. Aspiration biopsy of the testicular growth is not recommended.

The Aschheim-Zondek test is an important diagnostic aid. Before metastasis has occurred, treatment should include preoperative x-ray irradiation and orchiectomy. In those cases in which lymphatic or hematogenous spread is present, only radiation therapy of the primary mass and the secondary implants is advised.

Early diagnosis of malignant neoplasms of the genitourinary tract in children is necessary for successful therapy. In all cases, treatment should be by x-ray radiation and surgery combined; radiation therapy alone should be employed only in those cases in which widespread metastases are present.

**Prostatic Carcinoma: Endocrine, Roentgenologic, and Surgical Treatment.** Henry K. Sangre. Pennsylvania M. J. 47: 1213-1215, September 1944.

The author reports a series of 20 cases of prostatic carcinoma—10 adenocarcinomas, 1 squamous-cell carcinoma with malignant epithelial cells, and 9 undifferentiated carcinomas. Sixteen of the patients were over sixty years of age. The youngest—the patient with the squamous-cell carcinoma—was only eighteen. He died after two months, with pulmonary metastases, in spite of surgery and intensive deep x-ray therapy. Only 3 patients survived beyond five years. The author believes that the best results are obtained with suprapubic prostatectomy, bilateral orchiectomy, irradiation, and diethylstilbestrol, but considers the type of carcinoma of greater prognostic significance than any single therapeutic method.

A modified Pileher bag is described having four holes bored in the center so that radium needles can be placed in them when the bag is introduced postoperatively for hemostasis and removed when necessary, without disturbing the bag.

**Carcinoma in Young Persons.** Robert P. Morehead. Arch. Path. 38: 141-145, September 1944.

The author discusses the occurrence of carcinoma in young persons and reports 2 cases of carcinoma of the liver, one in a boy of thirteen and the other in a youth of eighteen; 2 cases of carcinoma of the cervix, in patients nineteen and twenty years of age; and 3 cases of carcinoma of the body of the uterus, in women under the age of thirty.

**Pseudocarcinomatous Hyperplasia in Primary, Secondary and Tertiary Cutaneous Syphilis.** Herbert Lawrence. Arch. Path. 38: 128-131, September 1944.

Pseudocarcinomatous hyperplasia superimposed on a gumma is frequently treated as carcinoma instead of syphilis. Extragenital primary syphilis with pseudocarcinomatous hyperplasia may also be confused with carcinoma, particularly because of the frequency with which the former occurs at carcinoma-bearing sites. Occasionally a solitary lesion of late secondary syphilis or of precocious benign tertiary syphilis presents a problem in diagnosis. Too frequently a carcinomatous-looking lesion of the skin or the mucous membrane is removed surgically or irradiated without the possibility of syphilis entering the clinician's mind and without a serologic test for syphilis being performed. The omission is particularly serious in the presence of a lesion of the face, lip, tongue, vulva, or cervix.

Pseudocarcinomatous hyperplasia occurs in primary, secondary, and tertiary cutaneous syphilis. It is frequently difficult to distinguish histologically between

this hyperplasia and carcinoma, which would account for some of the reported "cures of cutaneous carcinoma" by antisyphilitic therapy. An adequate history of the case and a report of a serologic test for syphilis should accompany the specimen to the pathologist.

Three cases are presented, illustrating pseudocarcinomatous hyperplasia occurring in primary, secondary, and tertiary cutaneous syphilis.

**A New Nasopharyngeal Radium Applicator.** M. William Clift. *Arch. Otolaryng.* 40: 208-209, September 1944.

A new type of nasopharyngeal applicator for irradiation of the eustachian tube is described and illustrated. With this applicator the technic of insertion and with-

drawal is simplified and discomfort to the patient is minimized. Its over-all length is 6 1/2 inches. It consists of four parts: a brass capsule, capable of holding five 10-mg. needles or a 50-mg. capsule of radium; a shaft of silver wire; a handle one inch in length with one surface flattened; a sliding stop which automatically locks at any position. This stop consists of a metal disk united to an ordinary tie pin clasp. When the applicator is inserted and the capsule rests in the proper position, the stop is moved along the shaft until it rests against the nose, where it locks, and is held in place by a strip of adhesive tape. Since lymphoid tissue may be distributed throughout the entire eustachian tube, it is desirable that the beta rays be absorbed by adequate filtration.



# RADIOLOGY

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# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES  
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## Antral Gastritis: Roentgenologic and Gastroscopic Findings<sup>1</sup>

WALTER W. VAUGHAN, M.D.

Durham, N. C.

PYLORIC AND prepyloric lesions can usually be recognized by present methods of x-ray study. Nevertheless, it is often as difficult to make a differential diagnosis of the detected or suspected gastric lesion as it might be of some obscure pulmonary pathological process. Carcinoma, benign ulcer, syphilis, hypertrophy of the pyloric muscle, and antral gastritis may at some particular phase of development so closely simulate one another that a differential diagnosis resolves itself into a matter of problematic enumeration based on the known percentage incidence of the respective lesions.

Morgagni (1) in about 1740 gave the first classical description of an erosive or ulcerating gastritis. He described some of the erosions as being gangrenous and stated that the process involved not only the stomach but extended down into the duodenum and jejunum. His conclusion that the ulcerations were due to something that the patient had eaten were probably not too erroneous, since patients who die of lysol poisoning within seventy-two hours after ingestion often present gastric and duodenal lesions closely simulating Morgagni's original description.

Rokitansky (2), in 1855, was the first to describe the mucosa of gastritis. The hypertrophy, nodular mucosal folds, and

mucopurulent secretion which he pictured have been observed by every pathologist and gastroscopist in advanced hypertrophic gastritis. Rokitansky (2) concluded that this was most common in the antrum of the stomach, a conclusion that has been verified by numerous recent observers.

### PATHOLOGY

According to Faber (3) gastritis is an inflammation of the gastric wall, of as yet unknown etiology, which begins in and may be limited to the mucosa, but which frequently extends to the deeper layers, even to the serosa. The disease may be generalized throughout the stomach but is often limited to or has its maximum effect in the antrum.

The gross pathological findings in antral gastritis may be divided into three groups:

(1) *An acute edematous process with involvement primarily of the mucosa and submucosa.* Gross examination reveals a brawny induration that closely simulates that of a malignant neoplasm. The mucosa is edematous and usually red. Edematous fluid oozes from the freshly resected specimen and there is marked retraction of the mucosa.

(2) *Ulceration of the mucosa with involvement of the muscularis submucosa.* Gross examination reveals an indefinite indura-

<sup>1</sup> From the Department of Radiology, Watts Hospital, Durham, N. C. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

tion with a moderate amount of thickening of the stomach wall. The mucosa is reddened, slightly edematous, and thickened. There are usually multiple superficial, sharply demarcated ulcers varying from 1 to 4 mm. in diameter. These ulcers may be covered with muroid and mucopurulent secretion. They frequently show evidence of recent hemorrhage, and their borders often show some granulation tissue

of peristalsis. The degree of aberration will depend upon the location, extent, and type of lesion. Since the antrum is the most important part of the stomach so far as motility is concerned, it is obvious that antral lesions will produce the greatest changes in motility.

The observations of Golden (4) on the gastric mucous membrane and antral systole are doubtless among the greatest con-

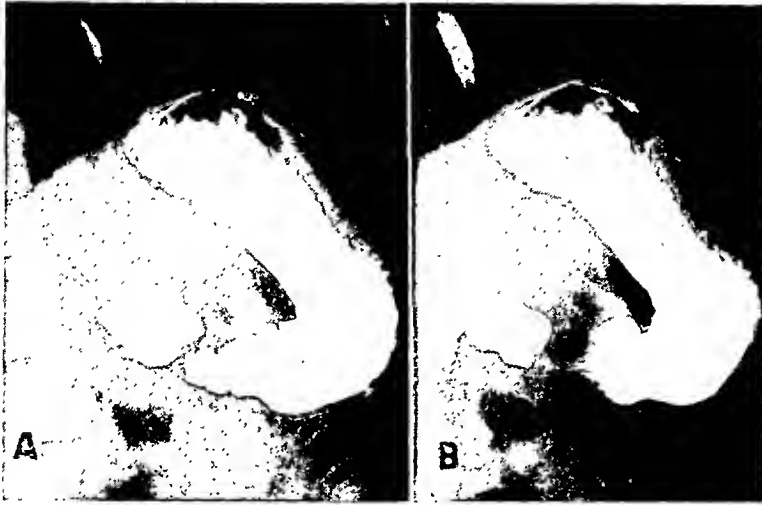


Fig. 1. Normal stomach showing antral systole as described by Golden (4). Note criss-cross of folds in the first roentgenogram (A) and smooth straight folds in the second (B).

that may, when seen through the gastroscope, simulate malignant lymphoma.

(3) *A chronic inflammatory process with hypertrophy of the mucosa and round-cell infiltration of the muscularis submucosa extending down to the serosa.* Gross examination shows definite infiltration and thickening of the entire stomach wall closely resembling the infiltration of a malignant growth. The mucosa is firmly adherent to the underlying submucosa as a result of the long-standing inflammatory process. The mucosal folds are greatly thickened and beaded, presenting a wart-like surface. Superficial ulcerations are infrequent but may occur.

#### PERISTALSIS AND MOTILITY OF THE MUCOUS MEMBRANE

Any pathological infiltration of the gastric mucosa, submucosa, or gastric wall will produce some change in the mechanism

tributions that have been made for both the roentgenologist and gastroscopist in the study of early antral lesions. I quote:

"As the narrow peristaltic wave enters the antral region, its relaxing edge decreases and its contracting edge increases in speed, closing off a portion of the lower end of the stomach and under normal conditions resulting usually in the expulsion of gastric contents. Then the wall relaxes promptly, and the lumen returns to its normal width and contour. This is known as the antral systole. Observations on a dog's stomach made in this department after the placing of opaque markers beneath the serosa suggest that the antral systole is associated with a contraction of the longitudinal muscle toward the pylorus.

"The normal mucous membrane of the stomach is freely movable over the muscle. This is easily demonstrated by palpation of a fresh specimen, by the separation of the



Fig. 2. Case II. July 14, 1943. Gastroscopic examination shows marked edema of the antral mucosa. No ulcerations noted.



Fig. 3. Case III. March 21, 1944. Gastroscopic examination shows edema, reddening, and superficial ulceration of the antral mucosa.

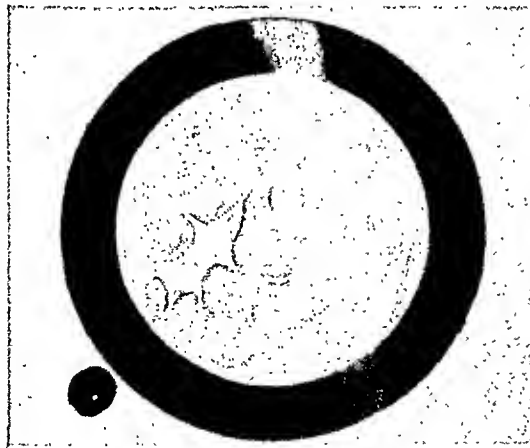


Fig. 4. Case IV. Sept. 25, 1943. Gastroscopic examination shows thickened and nodular gastric mucosa with one superficial ulcer; interpreted as either malignant lymphoma or hypertrophic gastritis.

mucosa from muscle wall when the stomach is opened at necropsy and by the projection of the mucous membrane over the edge of the muscle when the living stomach is cut at operation. Forssell (5) has shown that the formation of mucosal folds is the result of independent contraction of the muscularis mucosae. Obviously this independent movement is contingent on the mobility of the mucous membrane and intact muscularis mucosae. In some cases the mucosal folds in the antrum run irregularly transverse to the long axis of the stomach, and when the antral systole takes place they appear to change direction and run neatly parallel with the long axis. I have observed this phenomenon in the dog's stomach as well as the human stomach. (It is more easily seen in the small intestine.) For this change to occur, a movement of the mucous membrane in a cephalad direction must take place, thereby stretching it tightly beneath the muscular contractions. Otherwise, as the antrum closes off, the crisscross folds will be exaggerated, pushed down in a caudal direction and jammed toward the pylorus" (Fig. 1).

In correlating the roentgenologic, gastroscopic, and pathological findings in 576 patients studied gastroscopically, I have found the antral systole and motility of the mucous membrane as described by Golden (4) to be the most accurate and valuable roentgenologic and gastroscopic observation in detecting early pathologic changes in antral gastritis. Enlarged mucosal folds are apparently of no significance unless ulceration can be demonstrated.

#### SYMPTOMS

The clinical symptoms of antral gastritis may simulate either a benign or malignant ulcer, as demonstrated in the four cases presented in this discussion. The most characteristic clinical findings are epigastric pain, which is usually made worse by food; nausea, especially in the morning; weight loss, and occasionally gastric hemorrhage. Benedict (6) reported seven deaths from gastric hemorrhage due to gastritis.

Many observers believe that the pain

associated with antral gastritis may be accounted for by the inflammatory infiltration in and around the sympathetic ganglia of the stomach. This was first suggested by Holsti (7). The weight loss, which may be as great as that noted in advanced malignant growth, is probably due to an impaired appetite and to limitation of food intake because of the associated pain.

#### ROENTGEN FINDINGS

The roentgen findings vary all the way from a temporary and persistent spasm of the antrum, with impaired, irregular, and ineffective peristaltic waves producing abnormal antral systole, to a constant filling defect such as may be seen in an antral or prepyloric carcinoma. If the lumen of the antrum is still patent so that a small amount of barium can be forced through, ulceration can frequently be demonstrated.

#### GASTROSCOPIC FINDINGS

The gastroscopic picture in antral gastritis depends entirely upon which one of the three pathological groups is represented by the case. Group 1 (Cases I and II) shows considerable reddening of the mucous membrane (Fig. 2), which is extremely edematous and closely simulates the oral mucosa following injection with novocaine. The antral channel may be completely occluded. Unless the pyloric sphincter can be well visualized, one can never be sure whether or not there is an underlying ulcer. Ulceration, however, is not common in this group. Group 2 (Case III) shows a red, rather edematous mucosa (Fig. 3). There are a number of superficial ulcerations from which bleeding is frequently seen through the gastroscope. There is usually a great abundance of mucopurulent material. In Group 3 (Case IV) the gastric mucosa has a cobble-stone appearance and is frequently rather pallid (Fig. 4). The mucosal folds are hypertrophied and appear beaded or wart-like. Ulcerations may occur but are infrequent. The normal shortening of the antrum associated with peristaltic waves is absent. The incisura

angularis and pyloric sphincter appear to be fixed in position.

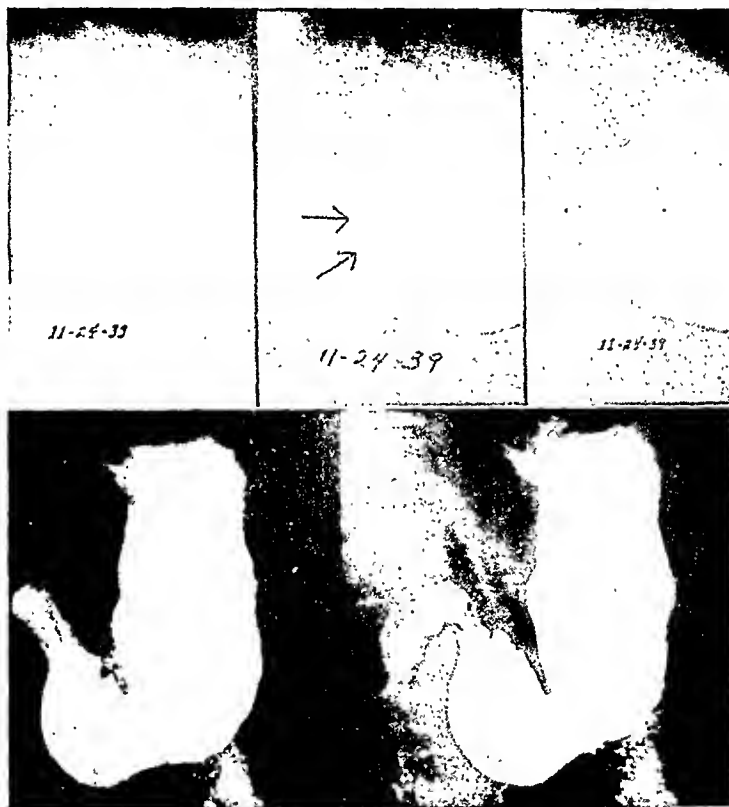
#### PROGNOSIS

The prognosis in antral gastritis is apparently quite good, although gastric resection may be necessary. Not a sufficient number of cases have been followed over a long period of time to determine the incidence of gastric cancer arising on a chronic

*Family History:* Irrelevant.

*Past History:* When in the hospital six months previously for cervical arthritis, the patient had some epigastric discomfort. X-ray examination of the stomach revealed moderate antral spasm but no definite lesion. Gastric analysis: no free HCl; total acidity 20°; occult blood positive. Blood count normal.

*Present Illness:* Onset one week prior to admission with rather severe but intermittent epigastric pain. The pain was constant in location. It was at first relieved by milk or food but later was made worse.



Figs. 5 and 6. Case I. Roentgenograms made Nov. 24, 1939, show a large filling defect in the prepyloric region on the greater curvature. This was interpreted as carcinoma. The two lower roentgenograms, made June 10, 1941, show a normal stomach.

inflammatory process. Feldman (8) reported 3 cases with cancer developing during intervals of three, six, and seventeen years. Repeated x-ray examinations had been most suggestive of an antral gastritis. Gastroscopy was not done in these cases.

#### CASE REPORTS

CASE I: J. S. P., white male, age 50, admitted Nov. 23, 1939.

*Chief Complaints:* Epigastric pain, nausea, vomiting, and loss of weight.

There had been a loss of weight of 10 pounds since the previous admission.

*Physical Examination:* The patient was well developed and fairly well nourished, not acutely ill. Examination was negative except for tenderness in the epigastrium. No masses were palpable.

*Laboratory Studies:* Complete blood count 5,200,000; Hgb. 110 per cent; white cells 5,850. Gastric analysis: free HCl 0; total acidity 15°.

*X-Ray Examination:* On Nov. 24, 1939, a filling defect involving the greater curvature in the prepyloric region was demonstrated, the appearance being most suggestive of carcinoma (Fig. 5). On June 10, 1941, the stomach appeared normal (Fig. 6).





Figs. 7 and 8. Case II. Roentgenograms made July 10, 1943, show partial pyloric obstruction with an antral filling defect. There was a 60 per cent six-hour residue. The picture was interpreted as probably representing a malignant neoplasm. Roentgenograms made Oct. 12, 1943, show a normal stomach. The patient was then symptom-free.

*Clinical Course:* This patient was discharged Nov. 27, 1939, to arrange certain business matters and was readmitted Dec. 15, 1939, for partial gastrectomy. X-ray examination Dec. 16, 1939, showed the lesion previously described to have almost entirely cleared. Operation was postponed. The stomach was re-examined Dec. 27, 1939, and found to be essentially normal except for a slight antral spasm. At the last x-ray examination, June 10, 1941, the stomach was considered entirely normal.

The patient died Feb. 22, 1943, of coronary occlusion. Autopsy was not obtained.

*Comment:* This patient probably had an acute edematous localized gastritis which cleared entirely under a medical régime.

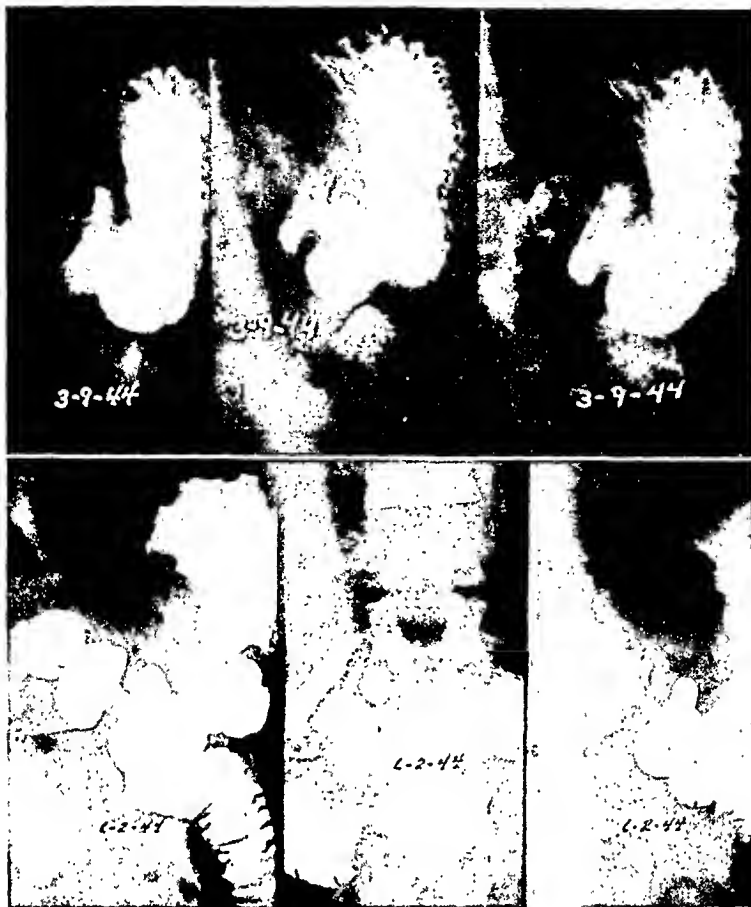
It is to be noted that there was a complete absence of free hydrochloric acid at all examinations.

CASE II: W. B., white male, age 59, admitted July 9, 1943.

*Chief Complaints:* Pain in the stomach, weakness, and lumbago.

*Family History:* One brother and one son had stomach ulcers. Father died of cancer of prostate; mother of coronary thrombosis.

*Past History:* The patient gave a history of duodenal ulcer since 1918, having followed a modified diet during the interval. He experienced an exacerbation nearly every Spring, characterized by fairly typical ulcer symptoms. Pain had always been re-



Figs. 9 and 10. Case III. Roentgenograms made on March 9, 1944, show a marked and persistent spasm of the antrum. The mucosal folds are irregular and thickened; the duodenal cap is deformed but no ulcer crater is demonstrated. The interpretation was probable antral gastritis.

Roentgenograms made June 2, 1944, show great improvement in the appearance of the antrum. Only slight spasm is observed. Antral systole was slightly prolonged.

lieved by soda and milk until the present illness. There had been occasional nausea and vomiting.

*Present Illness:* The patient had not felt up to par for the past two months and had gradually lost his appetite. There had been a loss of about 12 pounds in weight. Three weeks before admission an attack of severe epigastric pain occurred, followed by nausea and vomiting. This was not relieved by alkalis. The pain persisted but to a lesser degree. It was described as a constant burning in the epigastrium.

*Physical Examination:* Blood pressure 188/100. Moderate arteriosclerosis. Marked tenderness in epigastrium. No palpable masses.

*Laboratory Studies:* Red blood count 4,350,000; Hgb. 86 per cent; white cell count 10,600. Gastric analysis: amount 110 c.c.; free HCl 55°; total acidity 73°; occult blood positive.

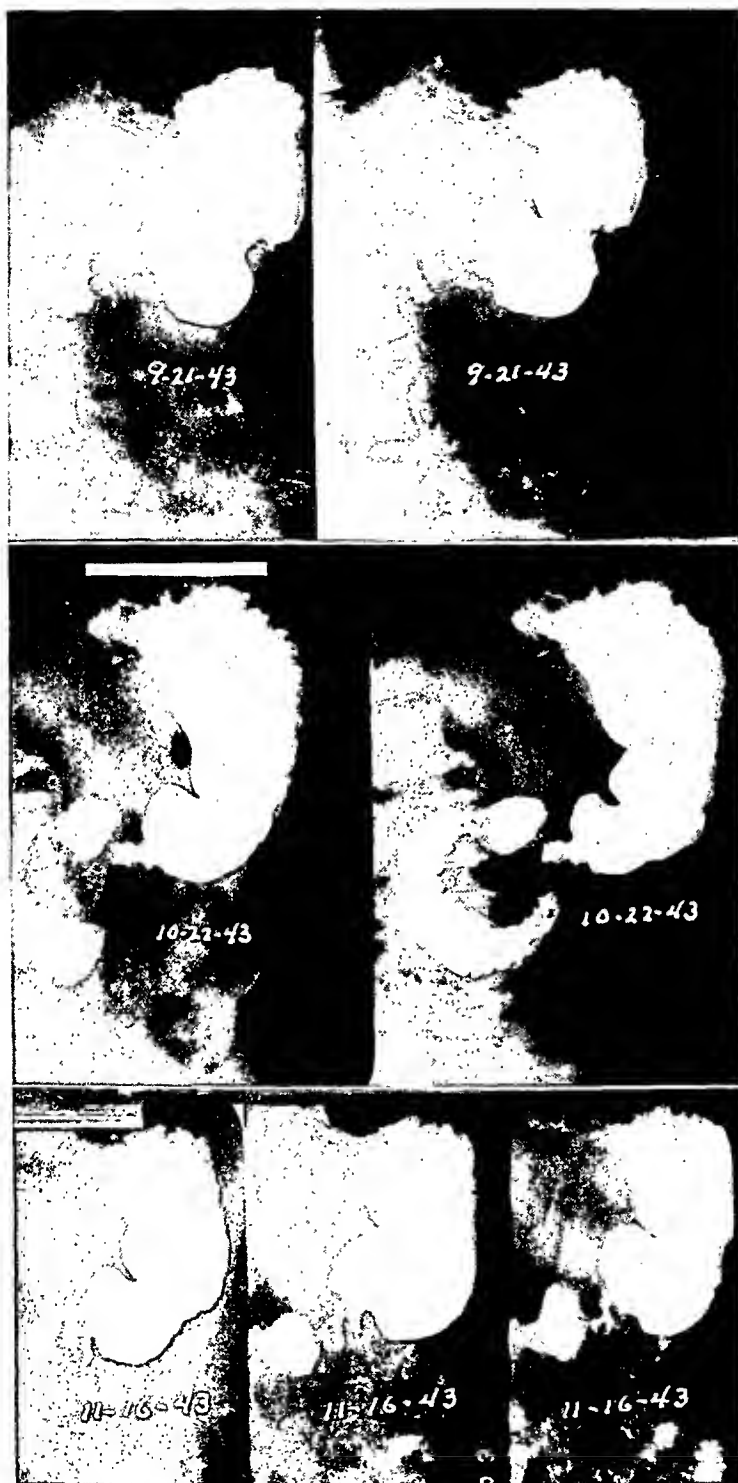
*X-Ray Examination:* On July 10, 1943, a filling defect was demonstrated in the prepyloric region, with 60 per cent six-hour barium retention. The duo-

denal cap was not visualized. Impression: prepyloric gastric lesion, possibly carcinoma (Fig. 7). On Oct. 12, 1943, the stomach and duodenum were essentially normal (Fig. 8).

*Gastroscopic Findings* (July 14, 1943): Marked edema of the antral mucosa with considerable reddening. No evidence of ulceration to suggest a malignant tumor. Impression: antral gastritis with edema (Fig. 2).

*Comment:* This patient apparently had an acute edematous antral gastritis with almost complete occlusion of the antral lumen. This cleared entirely on a medical ulcer régime. It is impossible to determine whether or not there was an underlying prepyloric benign gastric ulcer.

CASE III: W. M., white male, age 36, admitted Feb. 20, 1944.



Figs. 11, 12, and 13. Case IV. Roentgenograms made on Sept 21, 1943, show persistent antral spasm and a small ulceration at the junction of the antrum and pars media. On Oct. 22, 1943, there was very little change in the antral lesion. The patient had in the meantime been on a strict ulcer régime. Roentgenograms made Nov. 16, 1943, still show the antral lesion with ulceration. Symptoms were unchanged.

*Chief Complaint:* Bleeding peptic ulcer for three weeks.

*Family History:* Non-contributory.

*Past History:* Irrelevant.

*Present Illness:* For the past eight or nine years the patient had suffered from gaseous indigestion with considerable bloating and discomfort; for the past seven years he had had epigastric burning, relieved by milk or food. X-ray studies made six years before admission were negative. Twenty-one days ago a sudden profuse hematemesis occurred, followed by another five days later. Multiple transfusions were given.

persistent pylorospasm noted on the previous examination had in great measure cleared. There was still definite thickening of the mucosa, especially in the antrum (Fig. 10).

*Gastroscopic Findings:* March 21, 1944, hypertrophic gastritis with ulceration (Fig. 3). June 1, 1944, healing gastritis.

*Comment:* This patient may be classified as Group 2, with ulceration. It is to be noted that he had rather severe gastric hemorrhage, apparently from the ulcerated hypertrophic gastritis. The second gastro-



Fig. 14. Case IV. Section through benign gastric ulcer. See Fig. 4.  $\times 50$ .

*Physical Examination:* The patient was well developed and well nourished, pallid, but in no acute distress. No abdominal masses were palpable. There was some tenderness in the epigastrium.

*Laboratory Studies:* Red blood cells 3,050,000; Hgb. 60 per cent; white blood cells 8,600. Gastric analysis was not done.

*X-Ray Examination:* On March 9, 1944, eighteen days after admission, x-ray examination showed a filling defect involving the antrum and considerable irregularity and thickening of the mucosal folds. No definite ulceration was noted. The duodenal cap was deformed but no ulcer crater was seen. Impression: Prepyloric lesion, possibly hypertrophic gastritis (Fig. 9).

On June 2, 1944, there was considerable improvement in the appearance of the gastric mucosa. The

scopic examination showed marked improvement in the general appearance of the mucosa. There was only one small superficial ulceration and there was no evidence of bleeding. The patient is now symptom-free.

CASE IV: E. S. C., white male, age 51, admitted Sept. 24, 1943.

*Chief Complaints:* Indigestion; loss of weight (25 pounds in past six months).

*Family History:* Irrelevant.

*Past History:* Irrelevant as given by patient.

*Present Illness:* The onset dated back about four to five weeks. There was slight intermittent pain in the epigastrium with a constant feeling that some-



Fig. 15 (above). Case IV. Section through gastric mucosa and muscularis submucosa. Note extensive round-cell infiltration.  $\times 100$ .

Fig. 16 (below). Case IV. Section through muscularis submucosa. Note extensive inflammatory reaction around ganglia and ganglion cell, indicated by arrow.  $\times 250$ .

thing was wrong. The discomfort was not altered by food intake or alkalis. Appetite continued fairly good.

**Physical Examination:** The patient was well developed but somewhat undernourished, not acutely ill. There was slight tenderness in the epigastrium just below the xiphoid process. No masses were present. Heart and lungs were normal.

**Laboratory Studies:** Red blood cells 4,750,000; Hgb. 94 per cent; white blood cells 6,400. Gastric analysis: amount 150 c.c.; free HCl 19°; total acid 27°; occult blood strongly positive.

**X-ray examination** showed an ulcerating lesion on the anterior wall of the stomach at the junction of the antrum and media, possibly an early carcinoma (Figs. 11, 12, and 13).

**Gastroscopic Findings** (Sept. 25, 1943): At the junction of the media and antrum on the anterior wall there was a sharply demarcated, irregular ulcer, measuring approximately  $1.4 \times 0.4$  cm. in diameter. The adjacent mucosa throughout the antrum was nodular, red, and edematous. Impression: A malignant ulcer, such as lymphoma, or hypertrophic gastritis with ulceration (Fig. 4).

**Clinical Course:** The patient was placed on a strict ulcer régime for a total of eight weeks, including bed rest for the first three weeks. X-ray and gastroscopic examinations were repeated Oct. 22 and Nov. 16, 1943, with no appreciable change. Partial gastrectomy was done Nov. 26, 1944.

**Pathologic Diagnosis:** Marked hypertrophic gastritis with benign ulcer.

**Gross Examination:** An irregular sleeve resection of the pylorus was done, the resected portion measuring 12 cm. in width and 15 cm. in circumference. The irregularity consisted of an additional piece of gastric mucosa measuring about 50 mm. in diameter attached to the sleeve along the greater curvature. This appeared to be due to an additional cut through the stomach wall after a partial gastrectomy. The tissue proximal to the pyloric sphincter was edematous and thickened. No rugae were observed in this region. In the central portion of this area, approximately 2.0 cm. proximal to the pylorus, and in the region of the incisura angularis was a superficial erosion measuring  $2.0 \times 3.0$  mm. The mucosa was adherent to the submucosa and in the region of the ulcer presented a rather granular and wart-like appearance. The duodenal portion of the specimen, which averaged about 20 mm. in width, was slightly thickened and more congested than is usually seen.

**Microscopic Examination:** All sections of the stroma showed a marked increase in lymphoid infiltration, especially near the muscularis mucosa (Fig. 15). Germinal centers were seen in a few of the denser collections of lymphocytes. Sections through the eroded area showed a zone of granulation tissue which was being covered over by epithelium. A small amount of fibropurulent exudate was present on the surface (Fig. 14). The muscularis mucosa was somewhat distorted beneath this area. There was lymphocytic infiltration extending down around the sympathetic ganglia (Fig. 16). Impression: Chronic gastritis: superficial ulceration.

**Comment:** This patient had all the clinical and roentgen findings of a prepyloric carcinoma. The gastroscopic appearance also was suggestive of a malignant lesion. The impression of the surgeon who did the resection was that it was a malignant infiltration. Histologic studies of the resected specimen showed a chronic hypertrophic gastritis with a benign ulceration.

## DISCUSSION AND CONCLUSIONS

Three cases of antral gastritis have been selected for presentation from 576 cases studied gastroscopically. These have been verified by follow-up clinical studies and gastric resection. One additional case that roentgenologically and clinically had the appearance of antral gastritis is also presented. Practically the entire category of symptoms generally associated with gastritis, peptic ulcer, and gastric cancer has been found in these cases. The difficulties of differential diagnosis on the basis of the clinical history, physical examination, x-ray and gastroscopic examinations have been pointed out. Gastroscopy was most helpful in these cases. It should be used more frequently as a supplement to careful x-ray studies, and the results should be correlated with the roentgenologic, clinical, and laboratory findings. If there is any doubt as to whether the lesion is benign or malignant after the findings have been correlated, gastric resection should be done.

Every case of antral gastritis possibly has malignant potentialities. By correlating our roentgenologic and gastroscopic findings with the clinical course, we can more accurately evaluate the prognosis of the disease.

NOTE: I am indebted to my wife, Billie, for the gastroscopic illustrations and to Dr. R. L. Holman, pathologist at Watts Hospital, for the photomicrographs and description of the pathological findings.

Watts Hospital  
Durham, N. C.

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## DISCUSSION

Ross Golden, M.D. (New York, N. Y.): Doctor Vaughan has dealt very excellently with the topic, which I think is one of the most intriguing problems we have; which is the diagnosis of antral gastritis and spasm and its differentiation from carcinoma.

In one of the cases shown by Doctor Vaughan, ulcer of the lesser curvature, above the antrum, was present. I have the impression that ulcer of the lesser curvature proximal to the antrum occurs in one-third to one-half the cases with antral spasm and hypertrophy of the pyloric muscle. Some cases have ulceration in the antrum itself, in the narrowed region. Here, the penetrating craters may not be demonstrated by x-ray examination, but are wide open in the specimen after resection. The only apparent explanation for this is that the spasm succeeded in closing off the crater. If there is enough induration about the mouth of the crater, the spasm cannot close it off and it will be visualized. I have ceased to be surprised when the pathologist finds a crater, under these circumstances, which I had not demonstrated in the narrowed antrum.

Doctor Vaughan showed some very interesting cases in which the spasm was nicely relieved by treatment. In many we have seen, the treatment seemed to have no effect on the objective spasm, although the patient's symptoms were improved. I wondered whether the response to treatment has to do with the duration of the disorder. Possibly spasm which persists for a long time becomes associated with organic changes in the antral wall, which prevent relaxation, whereas in more recent cases the spasm can be relieved.

The serious problem is to find out whether cancer is present in the narrowed antrum. One difficulty is that carcinoma may occur in association with the spasm of antral gastritis. In one of our cases cancer developed in the scar of a healed ulcer in a spastic antrum which we had followed over a period of years. Gastroscopy is of high value in antral gastritis with spasm. Doctor Vaughan is to be congratulated upon his initiative in developing himself into a skilled gastroscopist and upon his excellent presentation.

Walter W. Vaughan, M.D. (*closing*): The most significant roentgenological finding in antral gastritis is an abnormality of the antral systole as demonstrated by careful fluoroscopy and serial films. It normally requires twenty-five to thirty seconds for a complete cycle in antral systole.

The technic for gastroscopy with a flexible gastroscope has been outlined in numerous articles and a few textbooks. The most important factor is care-

ful preparation of the patient. We use a moderate amount of sedation, combining morphine and atropine with one of the barbiturates in order to obtain as complete relaxation as possible. The throat and upper portion of the esophagus are anesthetized by surface anesthesia. The examination is done in the fluoroscopic room of the X-ray Department, where the desired degree of darkness may be obtained. A regulation fluoroscopic tilt table is satisfactory. The examination requires from two to five minutes. The majority of patients complain of less discomfort from a gastroscopic examination than from a routine fractional gastric analysis.

The chief contraindications to gastroscopy are: (1) obstruction of the esophagus by intrinsic or extrinsic lesions; (2) subacute perforation of a gastric lesion; (3) coronary disease; (4) psychosis. It is the responsibility of the gastroscopist to see that the necessary studies have been made to exclude these contraindications before attempting an endoscopic study of the stomach.

The addition of gastroscopy to roentgenology in our department for the study of gastric lesions has been found to be of inestimable value in the confirmation of suspected lesions as well as in differential diagnosis.





# The Roentgen Appearance of Lobar and Segmental Collapse of the Lung

## II. The Normal Chest as It Pertains to Collapse<sup>1</sup>

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A BASIC understanding of both the gross and roentgenologic anatomy of the normal chest is essential to early recognition and accurate evaluation of any disease process within the chest. It is the purpose of this paper, however, merely to emphasize the roentgen appearance of certain structures which are likely to change in shape, size, position, or contour when a lung, or any part of a lung, becomes collapsed.

While some changes are only suggestive of, or consistent with, a decrease in size of a lung or any part thereof, others, when clearly demonstrated, are almost pathognomonic of the presence of collapse.

Our observations are based on a detailed study of approximately 1,200 cases of tumor, bronchiectasis, foreign body, and tuberculosis. The only cases of tuberculosis that are included, however, are those in which a decrease in size of an involved lobe was marked. Postero-anterior and lateral roentgenograms on 160 healthy young adult hospital employees were also examined in an attempt to establish the variations which could be considered normal. In 10 of this group, roentgenograms were taken during both full inspiratory and full expiratory phases of respiration. In approximately 300 of the abnormal group complete bronchographic studies were available; in 3 other persons a complete bronchographic examination during both full inspiration and full expiration was made.

Because of the similarity of the anatomic structures of the two sides of the chest, each roentgenogram offers an immediate and, in the majority of cases, reliable

means of discovering unilateral abnormalities. Comparison of an abnormal lung with its normal opposite will often make possible accurate diagnosis of collapse of a lobe or a segment of a lobe.

Heretofore, the variations from normal usually accepted as diagnostic of collapse of the lung were: (1) an abnormal shadow of increased density, (2) elevation of the diaphragm, (3) displacement or shift of the mediastinum, and (4) narrowing of the rib spaces. These variations have been thoroughly studied and presented in the past and require no further discussion at this time. Our study has demonstrated the importance of three additional anatomic factors: (1) the appearance and position of the hilar shadows, (2) the arrangement of the vascular shadows in the peripheral portions of the lung fields, and (3) the demonstration of the actual size of a lobe as determined by the appearance and position of the septa or fissures of the lung.

Anatomically, the hili are approximately at the same level, but roentgenologically the left hilus usually appears to be a few millimeters higher than the right (Fig. 1). This is due, for the most part, to the fact that the left pulmonary artery, which forms the upper margin of the left hilar shadow, is more clearly visualized than the eparterial right main bronchus, which forms the upper margin of the right hilus. The vascular structures, as they leave the hilar areas may be distinguished, as a rule, as branches of blood vessels, the distribution of which is more or less uniform. Any marked deviation in the position of the hilus and in the pattern of the adjacent

<sup>1</sup> From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. One of a series of papers accepted for publication in October 1944.

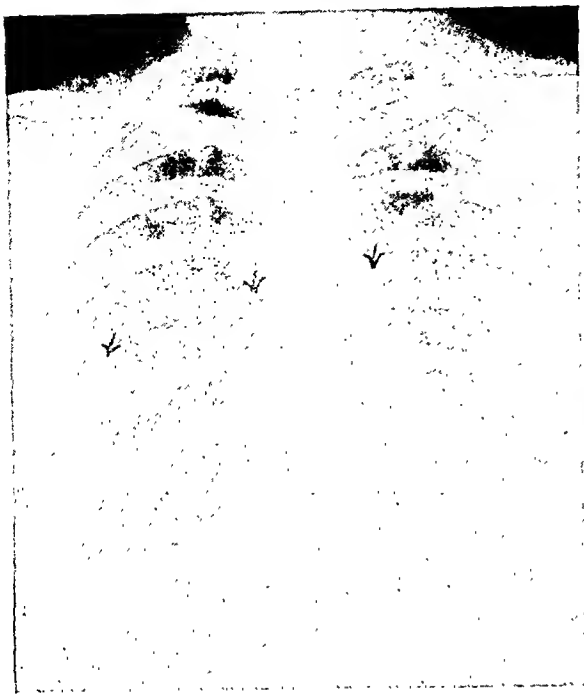


Fig. 1. Chest roentgenogram of a normal, healthy adult. Arrows indicate the superior margin of each hilus and the visible portion of the minor septum.

vascular structures strongly suggests spatial rearrangement within the lung. Such rearrangement frequently results in vertical displacement of the hilar shadow; that is, in collapse of an *upper* lobe the hilus moves upward, and in collapse of a *lower* lobe it moves downward (Fig. 2). When this occurs, one often has the impression that there has been a decrease in the size of the hilus of the involved lung. It is more likely, however, that this apparent decrease is due to the partial obscuring of the lung root by the shadow of increased density and by overlying structures, particularly in those cases in which the hilus is depressed.

The vascular structures in the periphery of the lung fields form a rather fine branching network. On comparison of the two sides of the chest, the pattern in each is seen to be similar in general arrangement and in number of structures visible per comparable area. When spatial rearrangement occurs and one portion of a lung or lobe occupies a much greater area than normally, these vascular structures are separated (Fig. 3). This separation of the

normal vascular network serves as a good index of the amount of rearrangement that has occurred. It is the greater amount of air between the vascular structures that accounts for the increased radiability which is usually interpreted as emphysema. Since this increased radiability is not always apparent, however, the spatial rearrangement within the lung is a more definite criterion for determining the presence and degree of emphysema.



Fig. 2. The left hilus is displaced inferiorly and obscured by the cardiac shadow. There is displacement of the mediastinum to the left, and the left diaphragm is slightly elevated. This appearance was produced by collapse of the left lower lobe due to bronchiectasis, proved by lobectomy.

In the majority of cases, it is possible to demonstrate the actual boundaries of the individual lobes of a lung by means of two roentgenograms. In the postero-anterior projection, determination of the exact lobar distribution of a lesion may not be possible, since obviously in the medial portion of the lung field, at all levels below the fourth thoracic vertebra, more than one lobe is projected on the same plane. Fluoroscopy and the lateral roentgenogram, however, will localize the lesion accurately. The approximating pleural surfaces that define the various fissures are dense enough, when caught on the same plane as the central ray, to be recorded on the roentgenogram, standing out as parti-

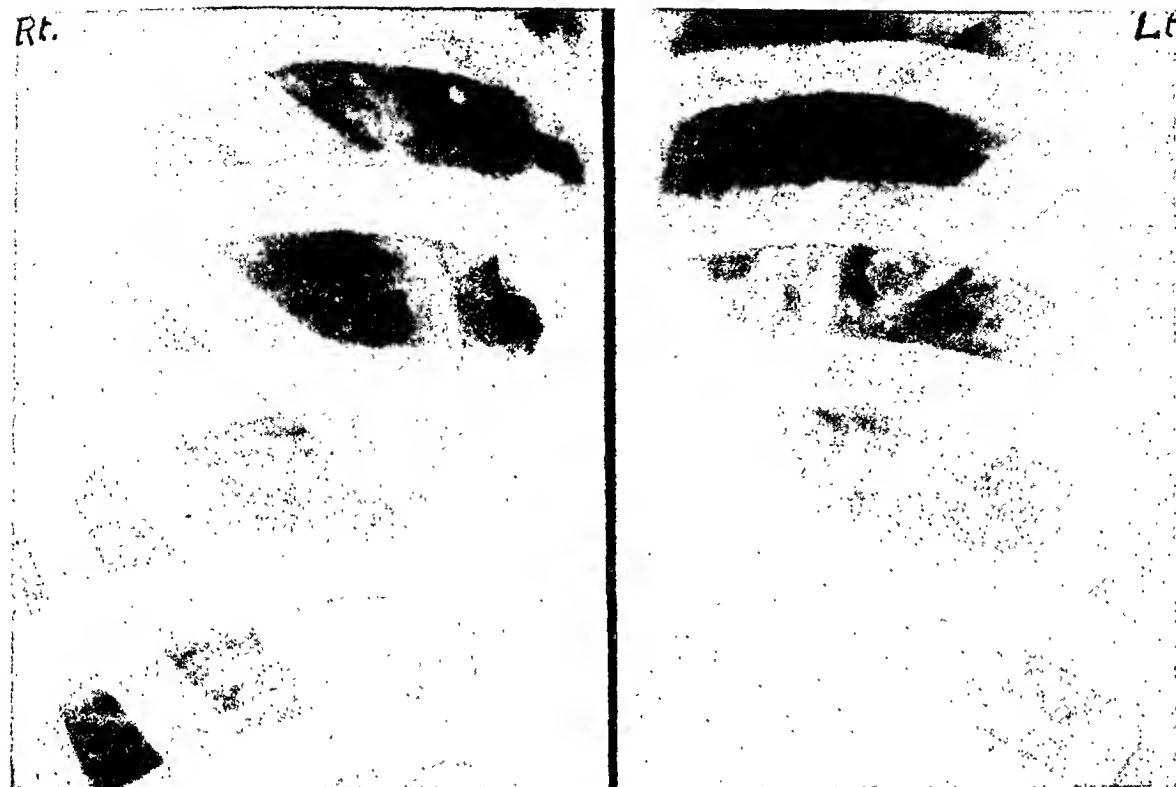


Fig. 3. Enlargement of comparable areas of the lung field of Figure 2. Comparison of the two sides shows fewer vascular shadows per unit area on the left.

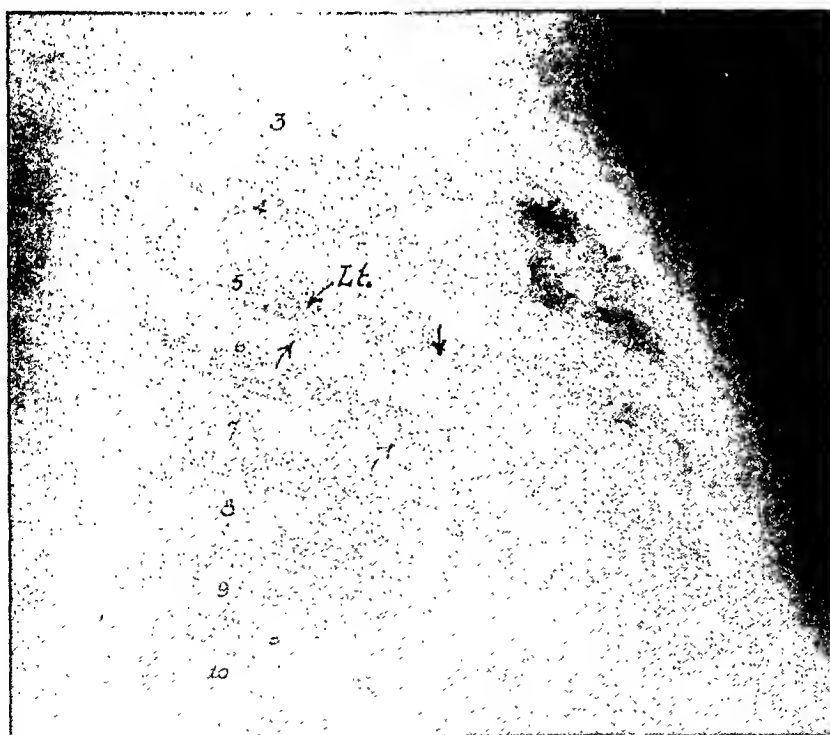


Fig. 4. Arrows indicate the major and minor septa of the right lung and a small portion of the major septum of the left lung.



Fig. 5. The posterior portions of the right major and minor septa are demonstrated.

tions between the lobes. The term septum or septa has, therefore, been considered roentgenologically appropriate and has been used in referring to these fissures. No attempt has been made to discuss anomalous septa.

The major septa divide the lungs on each side of the chest in much the same way, except that on the right side the middle lobe is a separate entity, whereas on the left, the lingula is not separated from the upper lobe and the lingular bronchus arises from the left upper lobe bronchus. In many persons, about one-third of the lower lobes is below the horizontal plane of the dome of the diaphragm and is thus not demonstrable on either single or stereoscopic postero-anterior roentgeno-

grams. The amount of lung obscured by the diaphragm, however, varies with the body build of the individual patient and with the phase of respiration at which the observation is made.

The major septa are demonstrated only on the lateral roentgenogram (Fig. 4). In this projection, they run roughly from the level of the fifth thoracic vertebra (Fig. 5) posteriorly to the most anterior portion of the diaphragm. (In supposedly normal young people, the inferior portion of a major septum meets the diaphragm at a point within 6 cm. of the anterior chest wall, but this observation may not be applicable in the older age group.) Roentgenologically, each major septum appears normally as an almost straight dividing line, with possibly a slight, gentle curve, the convexity being in either direction. On the left side of the chest, the upper lobe lies anterior to and above the greater septum, and the lower lobe below and posterior to it. On the right side, the upper and middle lobes lie anterior to and above the greater septum, while the lower lobe lies below it posteriorly. As a rule, one major septum can be distinguished from the other in the lateral roentgenogram, since on the right side it is met by the minor septum; also, the leaf of the diaphragm which a septum meets can usually be identified. The major septa do not change appreciably in position or contour with various phases of respiration.

Both the postero-anterior and lateral roentgenograms are of value in demonstrating the minor septum. A portion of it, if not the entire septum, can be seen in both these projections in approximately 90 per cent of those examined. This septum appears as a gently curved line and forms the boundary between the upper and middle lobes. It extends from the anterior chest wall, at about the level of the anterior portions of the third to fifth ribs, posteriorly to meet the greater septum in the mid-chest. Although the posterior portion of the septum does not change its position during the phases of respiration, the anterior portion moves upward during in-

spiration in proportion with the change in position of the sternum.

A change in the position or curve of a major septum will become more readily apparent if it is compared in the lateral projection with the septum on the opposite side of the chest. Any marked variation in the position or contour of any septum is strongly suggestive of spatial rearrangement, and should be correlated with the study of the appearance of the peripheral vascular shadows and the position of the hilus on each side of the chest.

#### CONCLUSIONS

The following changes from normal in anatomic structures are suggested as being of importance as they pertain to collapse of the lung, and particularly to collapse of a lobe or a segment of a lobe:

1. Change in the appearance and position of the hilar shadows.
2. Change in the arrangement of the vascular shadows in the periphery of the lungs.
3. Change in the position and contour of the lobar septa.

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# Fibrous Dysplasia of the Skull:

## A Probable Explanation for Leontiasis Ossea<sup>1</sup>

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OSTEITIS FIBROSA is a term that has been used for many years to designate any of a heterogeneous group of lesions of bone and is objectionable because it thus lacks any specific connotation. Employment of synonyms, such as von Recklinghausen's disease, fibrocystic disease of the bone, and osteodystrophia fibrosa, has not been helpful, for these designations also have no definite and universally accepted meaning. The first great advance toward clarifying this confusing situation was made when it was recognized that hyperparathyroidism was present in certain cases of so-called osteitis fibrosa. The changes in bone resulting from hyperparathyroidism and those attributable to other types of osteitis fibrosa were found to be dissimilar. It is now possible for roentgenologists to recognize hyperparathyroidism in most cases in which the bones are involved and they do not often confuse changes in bone resulting from that cause with those of other types of osteitis fibrosa.

The next contribution toward a better understanding of osteitis fibrosa was made by Albright and his associates in 1937. They described a syndrome which is characterized by osteitis fibrosa, pigmentation of portions of the skin, and endocrine dysfunction. They recognized that this type of osteitis fibrosa was not due to hyperparathyroidism and, therefore, called these lesions in bone "osteitis fibrosa disseminata" to distinguish them from those caused by hyperparathyroidism, which they called "osteitis fibrosa generalisata." The syndrome described by them has since been known as "Albright's syndrome."

In 1938 Lichtenstein described polyostotic fibrous dysplasia. The changes in

the bone were identical with those of osteitis fibrosa disseminata. Lichtenstein and Jaffe, however, found that these lesions often occurred without any manifestation of the non-skeletal components of Albright's syndrome. They observed that often several or many bones were affected but that in some cases only one bone might be involved. Because of this last observation, these lesions are now called "fibrous dysplasia of bone." If more than one bone is involved, the distribution may be indicated by adding the word "polyostotic" to the term "fibrous dysplasia."

Lichtenstein and Jaffe described fibrous dysplasia of bone as a developmental anomaly having its onset in childhood. When more than one bone is involved, there is a tendency for the lesions to be predominantly unilateral, but in many cases there is extensive bilateral involvement. Pain, disability, and deformity are usually present, often due to pathologic fractures. When maturity has been reached, there is either no further progression of the lesions or their progress is very slow. Pathologic fractures may occur at any time, however. The level of the serum phosphorus in cases of this type is normal. The concentration of serum calcium is normal or slightly elevated, and that of serum phosphatase moderately or greatly elevated. The increase in serum phosphatase is in direct proportion to the extent of the skeletal involvement. There is no evidence of hyperparathyroidism. Biopsy reveals that the medullary cavity of the involved bone is filled with gritty, grayish-white fibrous tissue containing newly formed trabeculae of immature bone. The bone is expanded in part or throughout, and the cortex is

<sup>1</sup> Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.



Figs. 1 and 2. Polyostotic fibrous dysplasia. The lesions of the bones of the thorax and of the femur are typical of those in the remainder of the skeleton. See also Figures 8 and 9.

thin. A long bone may be abnormally short. The pathologic changes in the bone with, perhaps, pathologic fractures, give a distinctive roentgenographic appearance (Figs. 1, 2, and 3). It must be emphasized that these lesions of the bone are not cysts, although, as a result of their radiolucency, they give that appearance many times.

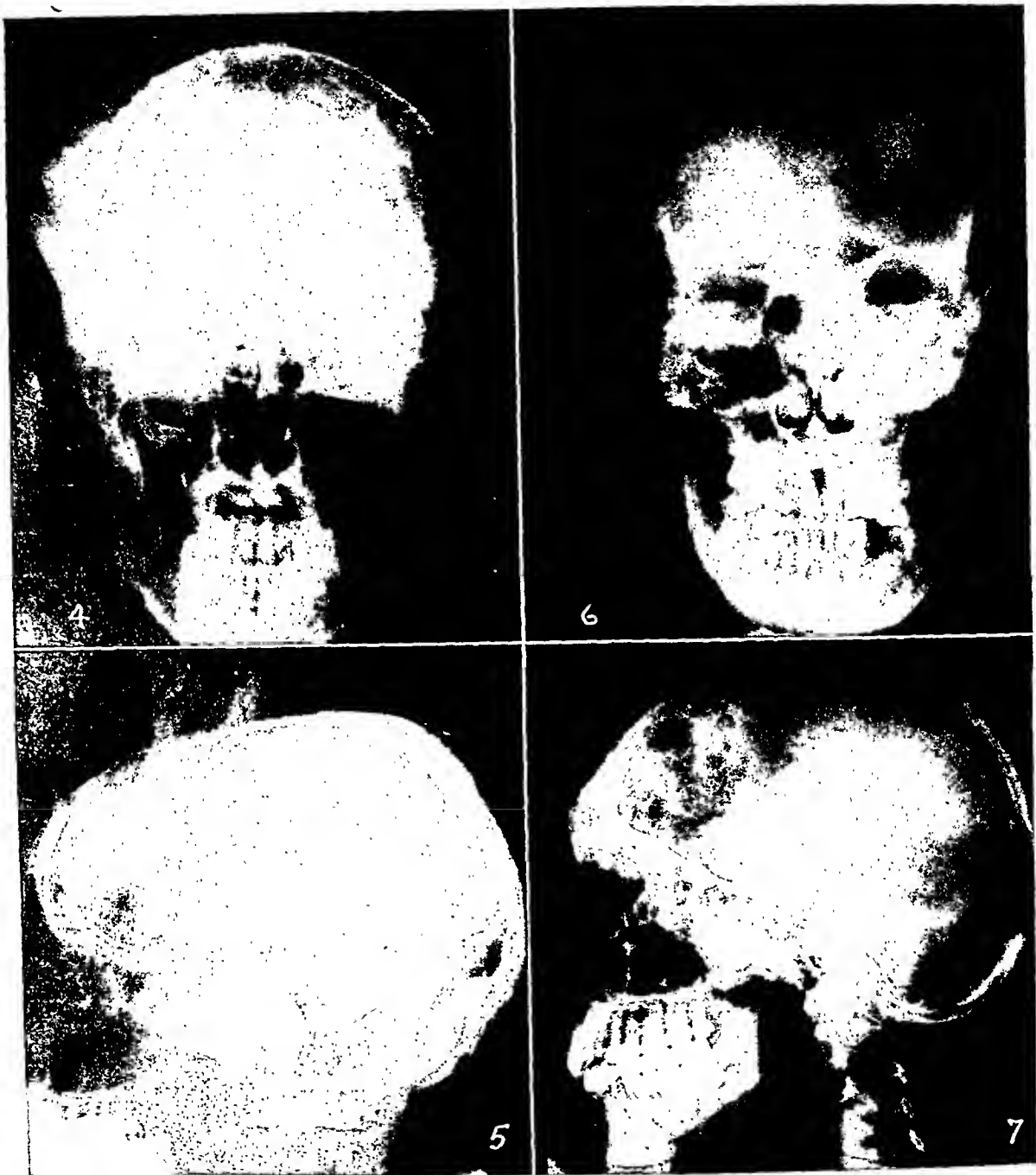
Lichtenstein and Jaffe stated that the extent of these developmental defects varies greatly. In many cases only the bone-forming mesenchyme shows disturbed development. However, when there is more extensive disturbance, non-skeletal abnormalities also may be present, and such changes as those of Albright's syndrome are manifest.

While there are objections to the term "fibrous dysplasia of bone" and it is not an ideal designation, yet it does serve to emphasize that the lesions constitute a distinct entity and it does replace the abused term "osteitis fibrosa" by one concerning which there is less confusion. It describes fairly adequately the pathologic process and indicates that these lesions are prob-



Fig. 3. Polyostotic fibrous dysplasia. Roentgenogram of the femur and tibia showing the extreme change that may be present.

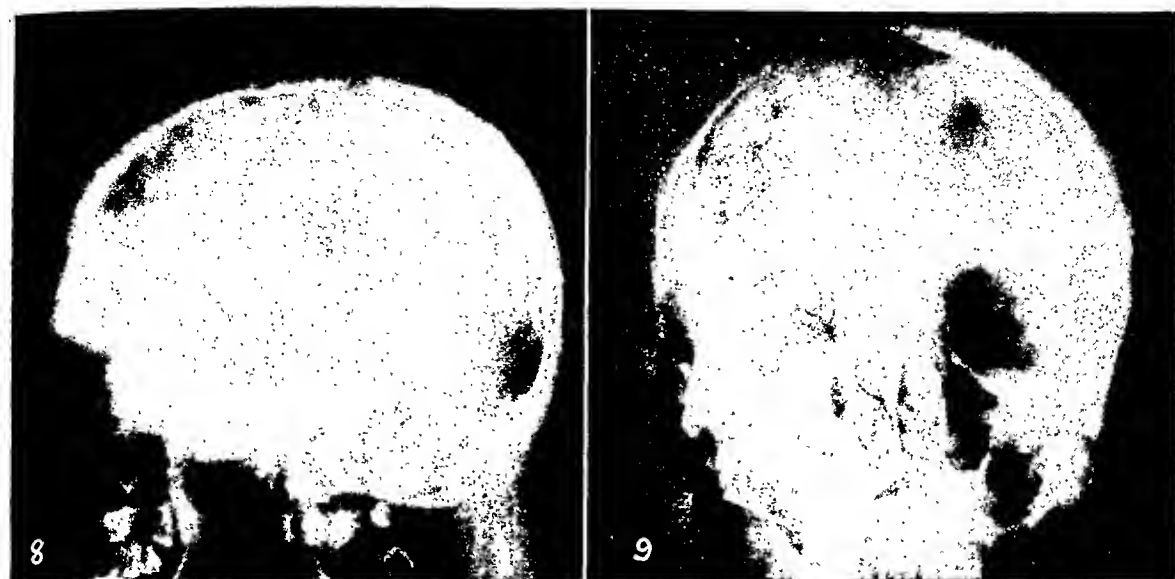




Figs. 4-7. Polyostotic fibrous dysplasia. The patient whose skull is shown in Figure 4 had typical fibrous dysplasia of much of the skeleton. Figure 5 is a roentgenogram of the skull of the patient whose femur and tibia are shown in Figure 3. Figure 6 is the skull of a patient with Albright's syndrome. Note the lesion in the mandible and the obliteration of the right ethmoid and maxillary sinuses. Figure 7 is from a case with lesions of the skeleton similar in character to those shown in the skull.

ably the result of a developmental defect. It does not carry any implication of hyperparathyroidism. The rather general acceptance of the name "fibrous dysplasia of bone" reveals a desire by many to avoid the term "osteitis fibrosa." When there

are also non-skeletal manifestations, the term "Albright's syndrome" is satisfactory. The roentgenologic appearance of long bones which are involved by polyostotic fibrous dysplasia has been described many times. On the other hand, sufficient atten-



Figs. 8 and 9. Skull of patient shown in Figures 1 and 2. The osteomatoid change in the base of the skull should be compared with the fibrous appearing lesions in the vault and occiput. Figure 9 shows especially well the obliteration of the ethmoid sinuses and the left antrum. There is also deformity of the left orbit.

tion has not been paid to the changes in the skull. Etter and Hurst found that next to the femur and humerus the bones of the skull are most frequently involved. The vault of the skull was involved in 73 per cent of the 15 cases of Albright's syndrome recorded by Falconer and his associates, and the face and the base of the skull in 67 per cent.

The roentgenograms in cases of polyostotic fibrous dysplasia, with or without Albright's syndrome, which have been reported in the literature, show changes in the skull that are distinctive and fairly consistent. Furst and Shapiro, Falconer and his associates, and Neller have briefly described the roentgenologic picture.

#### OBSERVATIONS BASED ON STUDY OF CASES

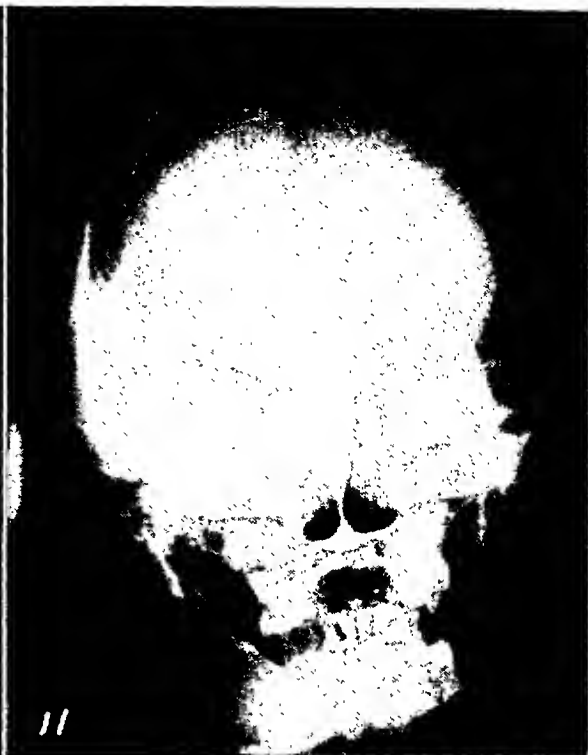
In order further to investigate fibrous dysplasia of the bones of the skull, the roentgenograms and clinical records in 5 cases of polyostotic fibrous dysplasia were first studied. These cases were selected because lesions of the skull were present. In one case, a diagnosis of Albright's syndrome had been made. The skeletal involvement in each instance was extensive and typical of the disease (Figs. 1, 2, and 3).

The changes in the skull observed in the

roentgenograms in these 5 patients were identical with those seen in cases reported in the literature. The lesions involving the vault, the occiput, and the mandible resembled closely the type of change which has been observed in the long bones in this disease. The bone had expanded and had the typical appearance that roentgenologists have learned to associate with fibrous dysplasia. Some areas looked sclerotic, but generally the appearance was that once thought to be due to cyst formation but now known to be due to fibrous tissue (Figs. 4 to 7).

The lesions in the frontal, sphenoid, ethmoid, and maxillary bones were different. In these regions the bone appeared to be densely sclerotic. It was abnormally thick, and the paranasal sinuses often were completely or partially obliterated. The density of the bone was often as great as that of an osteoma. For this reason it might be worth while to refer to this as an osteomatoid change caused by fibrous dysplasia of bone (Figs. 8 and 9).

Lesions of the skull in polyostotic fibrous dysplasia may cause asymmetry of the vault or face. The deformity may be predominantly unilateral, but there is almost always some bilateral involvement. De-



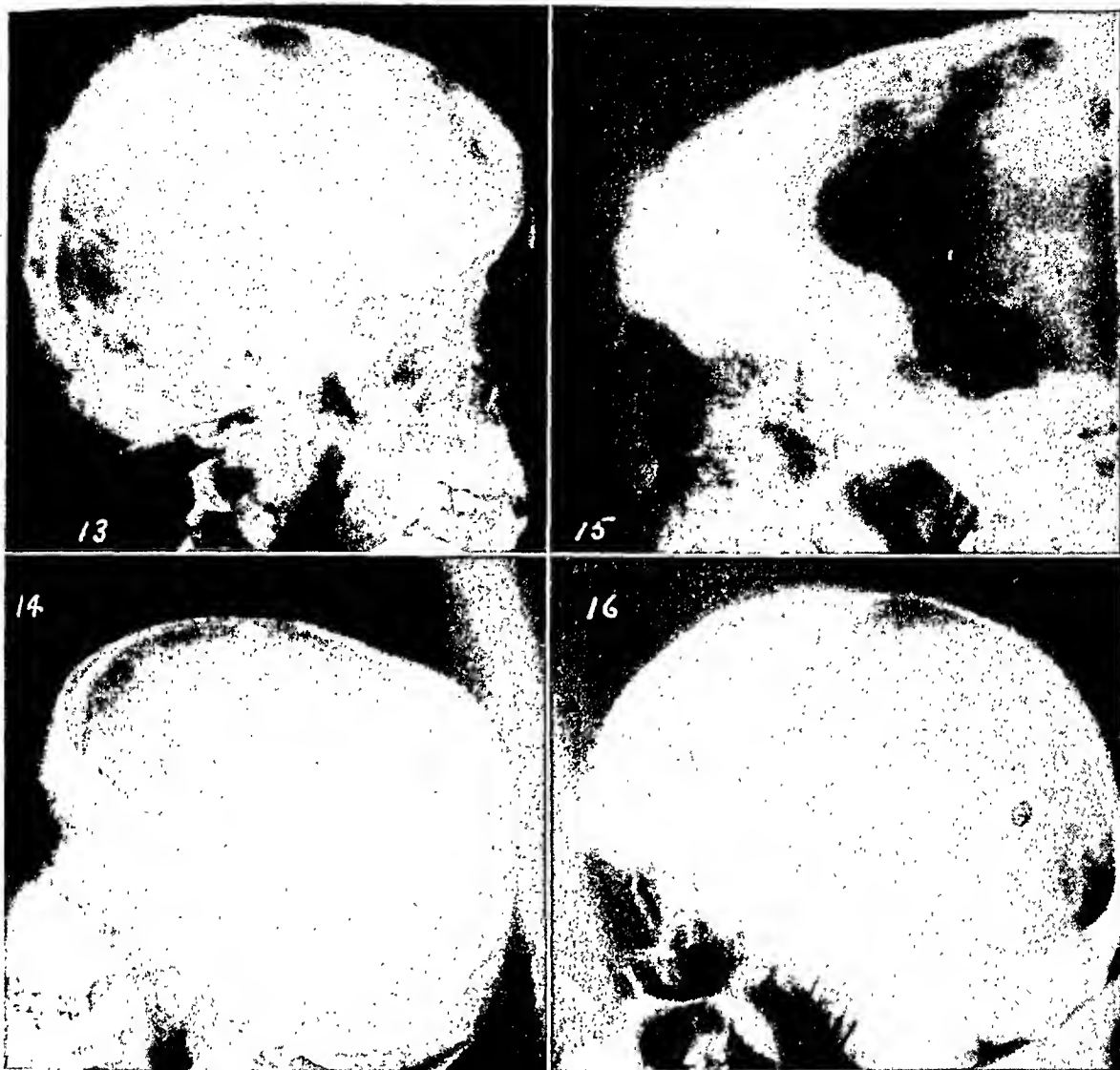
Figs. 10 and 11. Fibrous dysplasia of the skull. Figure 10 shows osteomatoid change in the left sphenoidal wings simulating the hyperostosis caused by meningioma. The lesion in the left half of the mandible helps identify this as fibrous dysplasia. Figure 11 shows enlargement of the left mandible, which led to roentgen examination of the skull in this case. The roentgenogram revealed obliteration of the ethmoid sinuses and left antrum and a lesion of the left temporal bone, as shown.



Fig. 12. Fibrous dysplasia of the skull, showing partial obliteration of the right antrum. Lesions of the right frontal bone and the right half of the mandible are also present.

formity of one orbit is not infrequent, and there may be ocular proptosis. Prominence of the frontal bone, maxilla, or mandible is often observed.

Recently Lichtenstein and Jaffe have emphasized that fibrous dysplasia may be limited to a few bones or may even involve only a part of one bone. For this reason it seemed probable that lesions might occur in the skull without involvement of the remainder of the skeleton. A search of the records at the Mayo Clinic revealed that within the last five years 10 cases have been encountered in which the lesions appeared to be limited to the skull. In 7 cases the remainder of the skeleton was not examined roentgenologically. In the other 3 cases roentgenologic examination of the remainder of the skeleton failed to reveal other lesions. In no case were there symptoms referable to any part of the skeleton aside from the skull. Five of these patients were males and 5 were females.



Figs. 13-16. Fibrous dysplasia of the skull. The patient shown in Figure 14 had, also, a lesion of the mandible which does not show in this roentgenogram. Figure 15 is an example of extreme osteomatoid change due to fibrous dysplasia.

In each case the lesions of the skull developed during childhood. There was no evidence of Albright's syndrome. The lesions in this group were similar to those in the cases of polyostotic fibrous dysplasia studied previously. In fact, these also are to be regarded as examples of polyostotic fibrous dysplasia, since in each instance more than one bone of the skull was involved. Roentgenograms from 7 of these cases are reproduced in Figures 10 to 16. It is likely that in some of these 10 cases of fibrous dysplasia lesions of other bones actually were present, also. Certainly this type of lesion in the skull should lead

to roentgenologic examination of the entire skeleton.

In many cases, fibrous dysplasia of bone is first detected when a pathologic fracture occurs. Diagnosis of the condition before the occurrence of this complication would be of great benefit to the patient, as proper precautions might prevent such an accident. Recently Helfet has advocated the oral administration of soluble aluminum salts to bring about calcification of these lesions and thereby strengthen the bone. The theory behind this treatment is not accepted by many, but Ghormley and Hinchey, as well as Helfet, have observed

encouraging results with its use. More extensive investigation is warranted.

Among the cases encountered at the clinic, is one which is especially interesting and illustrates well the need for complete roentgenologic examination of the skeleton when lesions of the skull are found. The patient, a boy of twelve, was seen at the clinic in 1927, when a diagnosis of diffuse osteoma of the skull was made. A review of the roentgenograms of the skull showed the lesions to be those of fibrous dysplasia (Fig. 17). This patient had always been large for his age, and enlargement of the head had been noticed since he was five years old. Congenital syphilis had been suspected as the cause of the skull lesions, but its presence was not confirmed. Areas of pigmentation were present in the skin on the back of the neck and over the sacrum. There was bony prominence of the lower part of the sternum, the fifth and seventh ribs on the right, and of a rib on the left. This case is, without much doubt, an example of Albright's syndrome. Undoubtedly there was fibrous dysplasia of some of the long bones of the skeleton.

#### LEONTIASIS OSSEA

The similarity, or rather the identical nature, of the lesions of fibrous dysplasia of the bones of the skull and those lesions which have been called "leontiasis ossea" cannot be discounted. Furst and Shapiro noted this similarity but believed that the two types of lesions could be distinguished. Falconer and his associates also mentioned the similarity and stated that leontiasis ossea is not a specific entity and might be due to polyostotic fibrous dysplasia in some instances. In cases of leontiasis ossea which have been reported in the literature, the roentgenograms of the skull reproduced invariably show changes identical with those of fibrous dysplasia.

Since leontiasis ossea is not a specific disease but merely describes a type of deformity, one cannot say that there is but one method of pathogenesis. In most cases, however, it seems to be due to fibrous dysplasia of the bones of the skull.

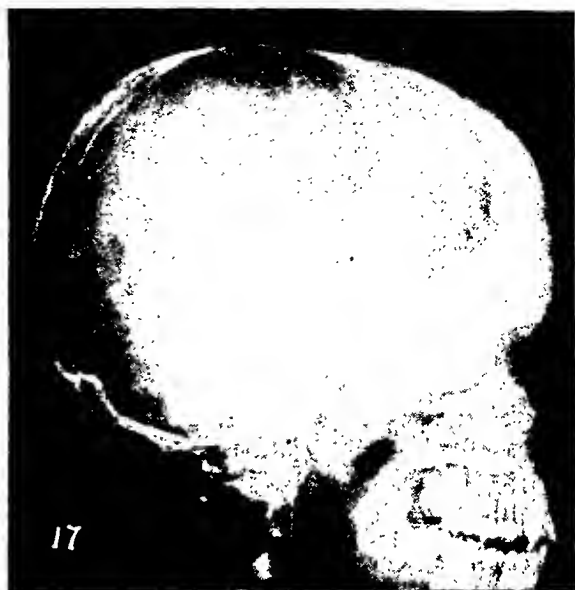


Fig. 17. Fibrous dysplasia of the skull which was probably associated with Albright's syndrome. The original diagnosis, made in 1927, was diffuse osteoma of the skull.

#### CONCLUSIONS

From this study the following conclusions are drawn:

1. Lesions of the skull associated with polyostotic fibrous dysplasia have a characteristic roentgenologic appearance.
2. Fibrous dysplasia of the bones of the skull occurs at times without obvious involvement of the remainder of the skeleton.
3. If fibrous dysplasia of the bones of the skull is found, roentgenologic examination of the entire skeleton should be carried out.
4. In most cases it seems probable that leontiasis ossea is a manifestation of fibrous dysplasia of the bones of the skull.

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### DISCUSSION

Lieut. Comdr. John D. Camp, (MC) U.S.N.R.: Dr. Pugh's paper illustrates, I think, the need for the continued interest of the roentgenologist in these bizarre bone lesions. We were able to segregate the condition of hyperparathyroidism from this group. Dr. Albright carried the matter further, with the recognition of the syndrome which now bears his name.

I was interested in a short editorial comment in last week's issue of the *Journal of the American Medical Association* [Sept. 16, 1944] in which it was suggested that Albright's syndrome, as represented by these cases of fibrous dysplasia that Dr. Pugh has shown, are all due to neurofibromatosis or von Recklinghausen's disease. I think a more convincing argument will have to be put forth before most of us can accept that theory.

Another important point concerning the group that Dr. Pugh discussed is the fact that these lesions occur in the young and that most of them show a tendency to regress in their rate of growth after puberty. This is especially significant in those lesions which we used to call fibrous osteoma of the nose and nasal sinuses. This is frequently a very deforming lesion and is important to the radiologist because, by giving adequate radiation therapy, he may be able to control its rate of growth. Thus, many of the disfiguring deformities of the face are

minimized, since, as just pointed out, the lesion has a tendency to slow up greatly after puberty.

Merrill C. Sosman, M.D. (Boston, Mass.): I would agree entirely with Dr. Camp in his discussion of Dr. Pugh's paper on the importance to roentgenologists of the recognition of this peculiar dysplasia of bone. When Dr. Fuller Albright reported his series of cases from Boston several years ago, we had already collected 9 cases of that same disease in patients who had been sent to Dr. Cushing for his determination as to whether or not they harbored a meningioma. That is the one condition that is most apt to be mimicked or even so diagnosed when fibrous dysplasia involves the cranial bones. We were working on those patients, getting biopsies and doing chemical studies, tending toward a paper on the subject, when Dr. Fuller Albright published his group, and we dropped the matter. Since then, however, we have seen six more cases. So there are fifteen in our little hospital in Boston.

Many names have been given to this condition. Fuller Albright called it "osteitis fibrosa disseminata." We called it "osteitis fibrosa localisata" because most of our cases were limited to the skull and even, like some of those of Dr. Pugh, to one side of the skull, particularly the perpendicular plate and the horizontal plate of the frontal bone, and occasionally the maxilla or mandible on the same side. Many of them had a definite depression of the eyeball. The orbit was partly overgrown by abnormal bone so that the patient presented exophthalmos as a symptom of the deformity and sometimes definite failure of vision due to the dislocation of the eyeball.

I can add one thing to Dr. Pugh's observations and Dr. Camp's discussion, and that is that the growth of this abnormal bone can apparently be stopped and it can be turned into more adult bone by x-ray treatment, and this does not require a very large dose, 750 to 800 r. (I hope you will avoid the excessive doses which we discussed in the therapeutic section yesterday, which may produce brain damage.) Three of our group of patients had definite cysts. They were not neoplastic areas in the bone but a cystic degeneration. In two of them we did biopsies. The erroneous histological diagnosis in one was giant-cell tumor and the other was called a myeloma. Both healed promptly with x-ray therapy. That is one indication of some possible benefit.

# Radiation Therapy of Carcinoma of the Thyroid<sup>1</sup>

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**M**OST PAPERS on carcinoma of the thyroid are from centers where great numbers of patients with thyroid disease are treated. The volume of patients seen and operated upon permits the observation and treatment of a large number of early malignant neoplasms. The experience with thyroid carcinoma in a general hospital is quite different. At Bellevue Hospital only 64 cases of thyroid carcinoma have been seen since 1924 in the Radiation Therapy Department. These cases, unlike those seen at centers of thyroid treatment, are for the most part far advanced. Many of the patients were referred from other institutions where surgery had been done but no radiation had been given until recurrence or metastasis occurred.

There are many interesting and informative papers on carcinoma of the thyroid. Lahey, Hare, and Warren (8, 15, 16, 27) have written a series of reports on the findings at the Lahey Clinic. In the most recent paper a series of 231 cases is summarized. Another series, that of the Cleveland Clinic, was recently reviewed by Portmann (23, 24), who reported 220 cases seen since 1922. A third extensive series reported by Pemberton and his associates (1, 18, 19, 20, 21, 22) consists of 774 cases seen at the Mayo Clinic between 1907 and 1937. Welti and Huguenin (29) reported 88 cases, and Watson and Pool (28) 167. Many other excellent papers describe the unusual features of from one to hundreds of cases.

## INCIDENCE

From a review of statistics, it might appear that the number of cases of malignant neo-

plasm of the thyroid is increasing. Authorities are of the opinion, however, that this increase is more apparent than real and that advances in clinical and pathological diagnosis are largely responsible. The proportion of malignant lesions among thyroid tumors has been variously estimated at from 1 to 5 per cent. Lahey, Hare, and Warren found that their 231 cases represented 1.2 per cent of 18,600 thyroids operated upon. Crile and Crile (2, 3) reported 289 carcinomas among 17,021 thyroid patients, or 1.69 per cent. These 289 cases constituted 3 per cent of nodular goiters. Pemberton found the incidence varying from 2 per cent in 1919 to 4.9 per cent in 1937. Welti and Huguenin's estimate is 1.3 per cent. According to Hare, deaths from thyroid cancer represent 0.66 per cent of all carcinoma deaths in the United States.

The age incidence varies widely, cases having been reported from early childhood to the nineties. Moreover, it is becoming increasingly recognized that carcinoma has a predilection for the thyroid in childhood. Because of this, it is no longer customary to defer operation in children with thyroid nodules. The incidence is greatest between the ages of forty and seventy, slightly less from thirty to forty and seventy to eighty. The occurrence of thyroid carcinoma in the various decades among our 64 cases is presented graphically in Figure 1. The average age is about fifty years and is slightly lower in females than in males. There are far more cases among females, the ratio being approximately 2:1 in large series. Of our 64 cases, however, 32 were in males and 32 in females. Our youngest patient was born

<sup>1</sup> From the Radiation Therapy Department, Bellevue Hospital, Dr. Ira I. Kaplan, Director. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

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with a carcinoma of the thyroid (Case 1) and the oldest was eighty-three.

#### PATHOLOGY

One finds almost as many systems of classification of thyroid neoplasms as there are writers on the subject. Close analysis, however, shows the difference to be mainly one of terminology, for there is general agreement as to the types of neoplasm. The simplest classification is that of Pemberton. His classification, which is that of the Mayo Clinic, is as follows:

1. Papillary adenocarcinoma
2. Adenocarcinoma in adenoma (malignant adenoma)
3. Diffuse adenocarcinoma
4. Epithelioma
5. Sarcoma

**Criteria of Malignancy:** There is still some confusion as to the differentiation between benign and malignant thyroid tumors. The subject has been clarified, however, by Graham (6), who set the following standards which may be used as criteria of malignancy: (1) local invasion of capsule or surrounding structures; (2) recurrence of original tumor after surgery; (3) metastasis to lymph nodes or distant structures; (4) death due to the size of the tumor; (5) invasion of blood vessels. This last was Graham's outstanding contribution to the subject, for it may be easily recognized. He described the following stages of blood vessel invasion: (a) gross thrombus; (b) gross erosion; (c) microscopic presence of cells or tissue in blood vessels; (d) microscopic evidence of invasion of blood vessels other than capillaries or sinuses.

**Papillary Adenocarcinoma:** Papillary adenocarcinomas comprise approximately 30 per cent of malignant thyroid neoplasms. The lesion is of low-grade to moderate malignancy. There is, however, a tendency to early metastasis to the regional lymph nodes, and such metastases may be the presenting feature while there is still no palpable tumor in the

thyroid. This has led some to entertain the concept of lateral aberrant thyroids. Pemberton, however, considers such deposits almost always metastatic from a primary thyroid lesion. Though they metastasize early to the lymph nodes, papillary adenocarcinomas are slow to spread to the lungs and mediastinum and rarely involve other organs. Histologically they are characterized by their papillary structure. Even when the tumors are not completely resectable, the prognosis is good, for they are radiosensitive.

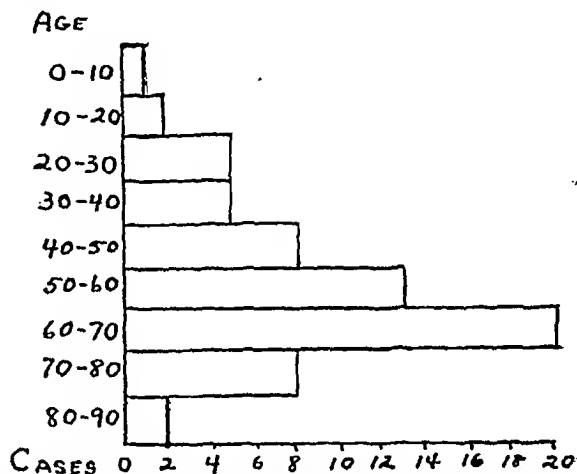


Fig. 1. Age incidence of 64 cases of carcinoma of the thyroid.

**Adenocarcinoma in Adenoma (Malignant Adenoma):** Approximately 50 per cent of malignant thyroid tumors are the so-called malignant adenomas. They are of moderate malignancy, chiefly of grades 1 and 2, though grades 3 and 4 are sometimes seen. The tumors vary in structure and are classed as fetal and alveolar or colloid. The majority are of the fetal type and are characterized by a variety of structures ranging from undifferentiated cords of cells to distinct follicles. Unlike the papillary adenocarcinomas, they are relatively late in reaching the lymphatics. It is not until the capsule has been broken that the tumor spreads by this route to involve the lymphatics and regional nodes. However, because of the tendency to invade the venous channels, these lesions spread more rapidly by the blood stream and give a much larger percentage of distant metas-

tases. To this group may be assigned the cases which were formerly considered as "benign metastasizing goiters." When complete excision is possible, prognosis is good. Even those lesions which cannot be completely removed offer a fair prognosis because of their radiosensitivity.

*Diffuse Adenocarcinoma:* In the larger series, diffuse adenocarcinomas comprise approximately 20 per cent of thyroid carcinomas. It is this group which has been

*Squamous Epithelioma:* Squamous epithelioma is most often the result of spread from neighboring structures. Through metaplasia, however, it may occur primarily in the thyroid, constituting perhaps 1 per cent of all carcinomas of the thyroid gland. The prognosis is very poor, for complete excision is difficult and the lesion is resistant to radiation.

*Sarcoma* is extremely rare and accounts for less than 1 per cent of cases. It is un-

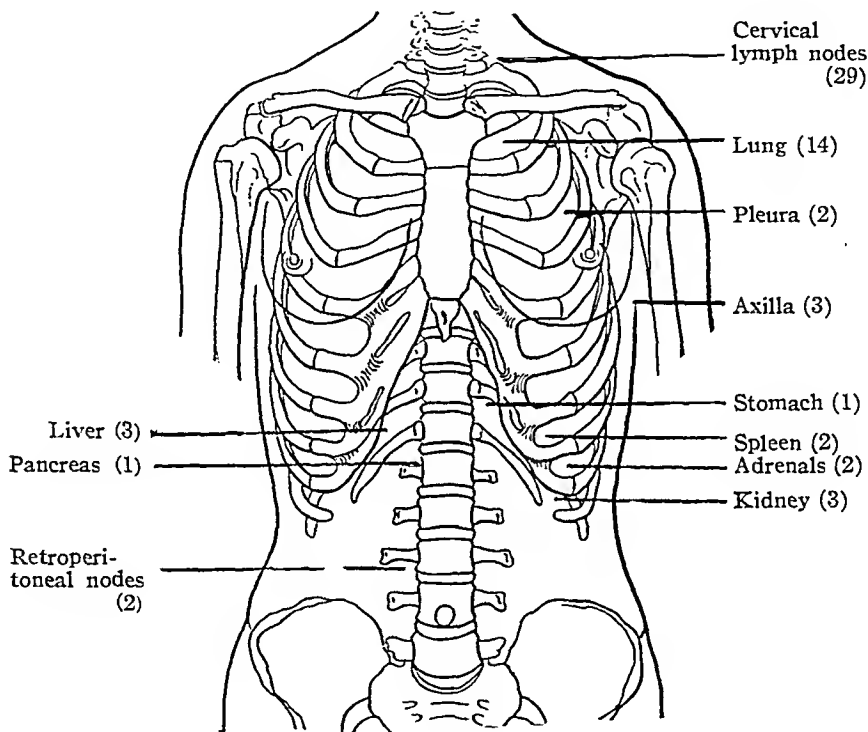


Fig. 2. Metastases in 64 patients with thyroid carcinoma. See also Fig. 3.

described under various headings, including sarcoma. There is a wide variety of cellular structure, from adult alveolar arrangement to undifferentiated, highly anaplastic invasive lesions resembling sarcoma. Diffuse adenocarcinoma is a more malignant type of lesion than those described previously. Metastasis occurs by way of both the lymphatics and the blood stream. Because of their tendency to extend into the surrounding tissues, these tumors are more frequently recognized clinically than the other types of thyroid cancer. They include the infrequent Hürthle-cell carcinomas.

usual for a patient with a thyroid sarcoma to survive as long as a year.

#### METASTASES

Metastasis has been reported from the thyroid to most of the structures of the body. Spread occurs by direct extension, the lymphatics, the blood stream, or any combination of these. The organs affected are, in the order of frequency: the regional lymph nodes, mediastinum, lungs, bones, liver, kidney, pleura, and brain. Metastases have also been described in the pancreas, breast, spleen, and even the retina and palate. In one of our cases (Case II)

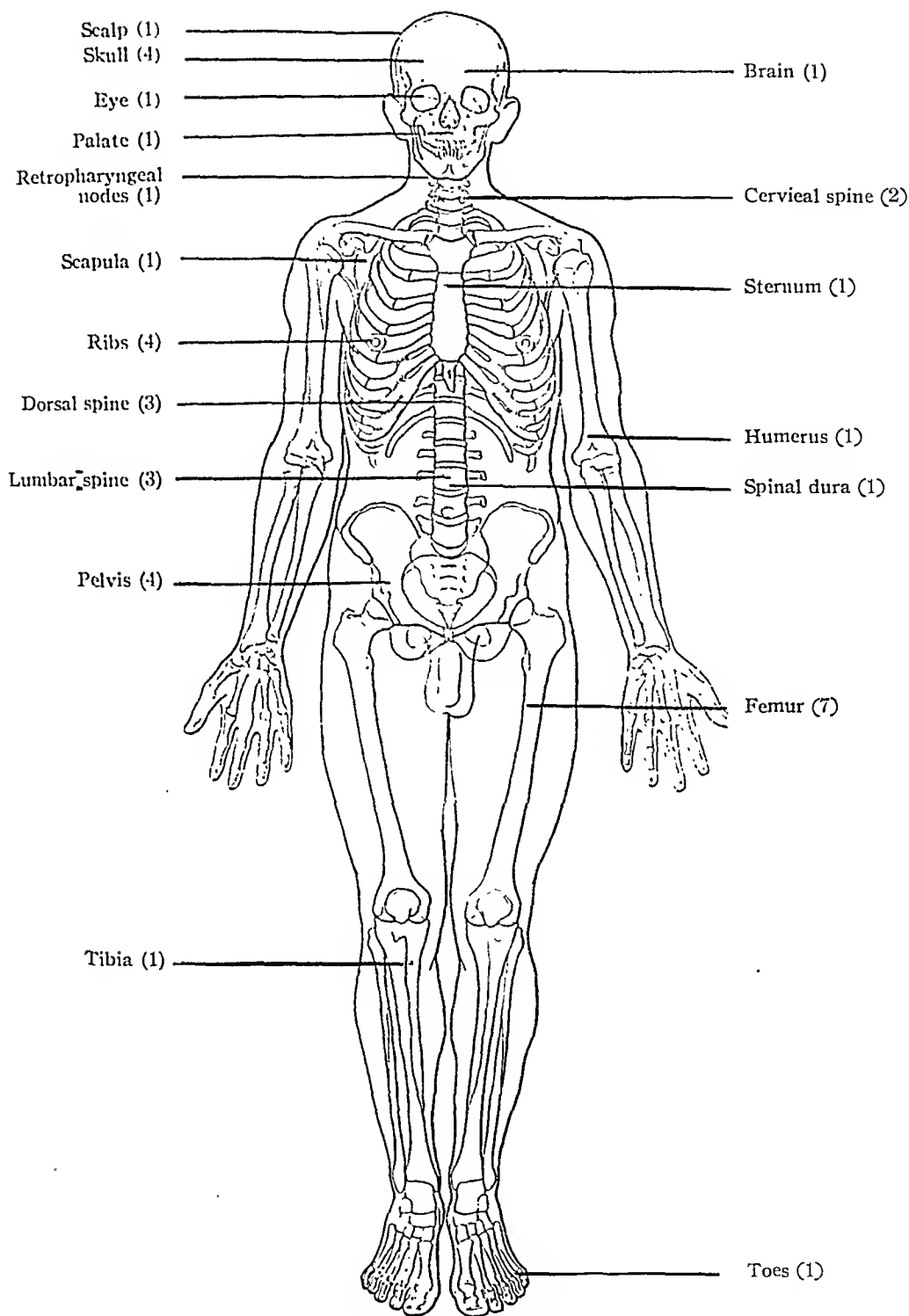


Fig. 3. Metastases in 64 patients with thyroid carcinoma. See also Fig. 2.

bone metastases appeared sixteen years after operation. Of our 64 patients, 15 showed no evidence of metastasis, 22 had metastases in a single organ, 15 in two organs, 7 in three organs, and 1 each in five,

six, seven, and eight different organs. (We consider the skeletal system as a single organ.) Figures 2 and 3 show the distribution and incidence of metastases in our series.

## CLINICAL PICTURE

In a large percentage of thyroid carcinomas, the diagnosis is made only at operation or even at subsequent pathologic examination. There is an inverse relationship between the stage of the disease and its clinical recognition. As clinicians are becoming more aware of the entity, however, a greater percentage of early cases are being recognized preoperatively. There are certain diagnostic criteria which are pathognomonic, and others which are highly suggestive.

(1) *Recent enlargement* of a pre-existing thyroid adenoma should always arouse suspicion of malignant change. The appearance of a growing mass in a previously normal thyroid should be regarded with suspicion. It will be found that in the average case there is a history of stationary adenoma for years, with enlargement beginning only in recent months.

(2) *Pressure symptoms* such as dyspnea and dysphagia are frequent complaints. Crile and Crile state that 82 per cent of their patients had pressure symptoms. These are often quite out of proportion to the size of the tumor.

(3) *Hoarseness*, resulting from involvement of the recurrent laryngeal nerve, is an important symptom. Benign thyroid tumors almost never cause paralysis of the vocal cords, whereas 15 to 20 per cent of patients with carcinoma of the thyroid manifest this phenomenon. According to Crile and Crile, abductor paralysis of one or both vocal cords in a patient with goiter who has not been operated upon is strong presumptive evidence of a malignant neoplasm.

(4) *Firm consistency* of the tumor is suggestive of malignancy. Some adenomas are firm, but they rarely have the stony hardness of adenomas which have undergone malignant change. This is particularly significant if it represents a change in consistency.

(5) *Change in outline* of the tumor is also important evidence. Invasion into and through the capsule may result in a firm nodular projection.

(6) *Loss of mobility* of a previously movable tumor may also follow invasion of the surrounding tissue, with fixation to underlying structures.

Despite these diagnostic criteria, carcinoma of the thyroid is still diagnosed preoperatively in less than 50 per cent of cases.

## DIFFERENTIAL DIAGNOSIS

The chief conditions from which malignant lesions of the thyroid are to be distinguished are benign adenoma with hemorrhage and thyroiditis of the Riedel struma type. In the former the enlargement will be more rapid than in malignant growth. In thyroiditis there are several points of differentiation. Though the gland may be stony hard, it does not lose its normal contour. Secondly, the condition is usually diffuse, involving both lobes and the isthmus, which is unusual for cancer. Thirdly, regional lymph node involvement is rare in thyroiditis.

Portmann has suggested a classification into stages which depend on the amount of involvement. He divides the cases into four groups. *Group 1* includes those cases in which a preoperative diagnosis of carcinoma was not possible and in which the diagnosis was made only on histologic examination. *Group 2* includes cases without the usual clinical evidence of carcinoma, in which the diagnosis is suspected because of recent enlargement or because of the patient's age. In *Group 3* there is clinical evidence of malignant growth extending beyond the capsule of the tumor but no distant metastases can be detected. *Group 4* is composed of those cases which have the qualities of Group 3 as well as clinical or roentgen evidence of distant metastases.

TABLE I: CLASSIFICATION OF 64 THYROID CARCINOMAS

Group I.....	3 cases
Group II.....	5 cases
Group III.....	5 cases
Group IV.....	51 cases

In Table I we have listed the distribution of our cases according to groups. It will be seen that the majority are in Group 4; very few are in Groups 1 and 2.

## RELATION TO HYPERTHYROIDISM

The presence or absence of hyperthyroidism is not of value in differentiating malignant thyroid lesions from those which are benign. Crile and Crile feel that in the presence of hyperthyroidism a diagnosis of malignant growth should be made with hesitancy. Pemberton, however, found evidence of hyperthyroidism with an elevated basal metabolic rate in 33.5 per cent of his patients. Davis (4) reported hyperthyroidism in 28 per cent of 50 cases. Others have confirmed this impression. Of our 64 patients, 25 per cent had an elevation of the basal metabolism rate varying from +15 to +100, as well as other evidences of hyperthyroidism.

## TREATMENT

The ideal treatment is early and complete excision with subsequent irradiation. Some cases which are inoperable may be rendered operable by irradiation. Recurrent nodules should be excised and the tumor-bearing area irradiated.

In *radiation therapy*, the aim is to give a cancerocidal dose to the tumor-bearing area and its lymphatic drainage. To do this in thyroid patients, we routinely treat both sides of the neck and the anterior and posterior mediastinum. Distant metastases are treated symptomatically.

For the average case, the factors are: 200 kv., 20 ma., 50 cm., 0.5 mm. Cu and 1.0 mm. Al or Thoraesus filter, with a portal of the size best suited to the patient. On each side of the neck we treat from the clavicle to the mandible. Over the anterior and posterior mediastinum we use 10 X 15-cm. portals in the average case. We give either 200 r to each of two portals or 300 r to one portal daily. All cases are treated to skin tolerance. After six to eight weeks, if the skin is in satisfactory condition, the treatment may be repeated.

When there is residual tumor following the second course of x-ray therapy, we prefer to change the quality of the radiation by using pure gamma rays in the form of the 5-gram radium pack or a collar con-

taining radium tubes. Subsequent therapy is given as indicated.

The complications which arise are treated symptomatically. Epidermitis occurs toward the end of treatment. Thorough lubrication of the skin with a bland ointment is prescribed and this lessens the severity of the reaction. When the skin breaks down, aquaphor ointment is applied. For severe pain, nupercain ointment is prescribed. For sore throat and laryngeal and tracheal irritation, gargles, bland foods, and nupercain lozenges are used. Should edema of the larynx occur, with obstructive symptoms, intubation should be tried and, if this is unsuccessful, tracheotomy should be performed.

## REPORT OF SELECTED CASES

CASE I: C. C., a nine-month-old white female, was first seen in our clinic on Dec. 20, 1940, with the following history. At birth, on March 12, 1940, a mass was observed in the anterior portion of the neck. X-ray treatments of undetermined quantity and quality were given in the hospital and the child was discharged two weeks after birth with no reduction in the size of the mass. At the age of six weeks she was readmitted because of continued enlargement of the mass in the neck, which was beginning to cause dyspnea and stridor when the child became excited or cried. Physical examination at that time showed three masses, firm and clearly defined, 3 to 5 cm. in diameter, one on each side in the anterior triangle and one in the mid-line of the neck. Though these were not fixed to the skin, there was fixation to the underlying structures. There were engorgement of the veins of the neck, respiratory stridor, and difficulty in swallowing.

On April 20, 1940, operation was undertaken, and the masses in the neck were found to have the appearance of thyroid tissue. They were surrounded by a dense capsule and were firmly fixed to the underlying tissues in the peritracheal area. A subtotal resection of the masses was performed.

The excised masses were somewhat nodular in appearance, firm on palpation, with a capsule over two-thirds of their surface. On section, they showed a meaty, lobulated surface from which no colloid could be expressed on pressure. Microscopic examination showed a diffuse picture of large cuboidal cells with an acidophil cytoplasm and small nuclei. These formed compact, small, and fairly uniform alveoli. In some sections there was a more marked variation in the size and shape of the alveoli than in others. Only a scant fibrotic stroma was present. The basement membrane appeared intact. *Diagnosis:* Adenocarcinoma of the thyroid of the Hürthle-cell type.

TABLE II: X-RAY TREATMENT OF CASE I  
(200 kv., 0.5 mm. Cu + 1.0 mm. Al filtration, 0.9 h.v.l., 20 ma., 50 cm. T.S.D.)

Field Treated	Field Size	Dose per Exposure (in air)	Total Air Dose	Interval	Dates
First Course					
Left neck	5 cm. circle	200 r	1,600 r	Daily	12/20/40 to 1/13/41
Second Course					
Right neck	6 cm. circle	200 r	1,400 r	1 area daily	2/11/41 to 3/11/41
Left neck	6 cm. circle	200 r	800 r	1 area daily	2/11/41 to 3/11/41
Post. mediastinum	8 × 10 cm.	200 r	1,000 r	1 area daily	2/11/41 to 3/11/41
Ant. mediastinum	8 × 10 cm.	200 r	1,000 r	1 area daily	2/11/41 to 3/11/41

The postoperative course was good, and the patient was discharged on June 19, 1940. There was still pressure on the vital structures, however, as evidenced by stridor when the child cried and difficulty in swallowing. For a short time after discharge the masses in the neck appeared to remain stationary. They then increased in size and caused further symptoms. The patient was admitted to Bellevue Hospital and was seen by us on Dec. 20, 1940.

On the right, in the anterior triangle of the neck, there was a firm mass measuring 4 × 3 × 3 cm. Below this were several nodes, 0.5 to 1.0 cm. in diameter, which were freely movable. On the left was a mass 3 × 2 × 2 cm. Several nodes, about 0.5 cm. in diameter, were palpable in each axilla and inguinal area. The veins of the neck were engorged and breathing was stertorous. X-ray examination showed a large soft-tissue mass on the right side of the neck, displacing the trachea to the left and compressing it. There was widening of the superior mediastinum. No evidence was obtained of metastases in the lungs or skeletal system.

X-ray therapy was instituted on Dec. 20. A 5-cm. area, including the node on the left side of the neck, was treated, as shown in Table II. During therapy and subsequently there was little or no evidence of regression of the tumor. On Feb. 11, 1941, therapy was begun to an area 6 cm. in diameter in the right neck and areas 8 × 10 cm. in the anterior and posterior mediastinum, as shown in Table II. There was roentgen evidence of decrease in the size of the superior mediastinal mass, but little change occurred in the size of the cervical masses. Dyspnea, stridor, and dysphagia increased. On March 31, 1941, it became necessary to do a tracheotomy. Bronchopneumonia developed and the child died on April 4, at the age of one year and three weeks.

CASE II: B. B., a 48-year-old white Rumanian Jewish male, was first seen in our service on Dec. 16, 1941, complaining of severe back pain which had been intermittent for a year. In 1923 he had a hemithyroidectomy in another city, for hyperthyroidism. His basal metabolic rate at that time was +45. The pathological report was adenocarcinoma in adenoma. The patient was then well until November 1939, when he again suffered from back pain, followed by the appearance of a mass over the dorsolumbar area. There were pain and weakness of the

legs and other evidence of tumor at the level of D12-L1. Laminectomy was done, and some tissue was removed for examination. The report was carcinoma metastatic from the thyroid to the spinal dura. Some relief of symptoms ensued, but backache persisted intermittently until the present admission following a day of severe pain. The patient complained, also, of nervousness, irritability, tremors, and palpitation.

Physical examination showed the following positive findings: *Head:* fine fibrillary twitching of tongue. *Neck:* transverse scar with no evidence of thyroid enlargement or masses. *Chest:* cardiac enlargement; regular sinus rhythm. *Back:* 25-cm. scar over dorsolumbar spine, tender to pressure. *Extremities:* fibrillary tremor of hands.

The blood findings were not significant. The basal metabolism rate on Dec. 12, 1941, was +45, on Jan. 8, 1942, +38.

Chest roentgenograms showed circular areas of increased density at both lung bases, suggesting metastatic deposits. There was a destructive process of the second left rib, with extension to the pleura. D-11, D-12, and L-1 showed evidence of laminectomy. In the skull a circular osteolytic area was demonstrable, and the right femur showed a similar area of involvement. Radiation therapy was given as outlined in Table III.

Some temporary improvement was observed during and after treatment, which was completed between Dec. 16, 1941, and Jan. 2, 1942. On Feb. 3, however, the patient was readmitted with exacerbation of pain and hyperthyroidism. Therapy was repeated as shown in Table III, second course. Some improvement followed, but the patient remained in the hospital until April 20, 1942, when he was transferred to another institution for custodial care. On Jan. 27, 1944, he was still alive. He complained of some pain in the right leg. He had been given radioactive iodine. The hyperthyroid symptoms were lessened and the basal metabolism was +6.

CASE III: N. S., a 25-year-old white Italian female, was first seen in our clinic on March 10, 1938. In 1937 a swelling had appeared in her neck, which gradually increased in size. During the year of its development she became nervous and irritable and experienced a choking sensation when she wore a collar, these symptoms being aggravated during the

TABLE III: X-RAY TREATMENT OF CASE II  
(200 kv., 0.5 mm. Cu + 1.0 mm. Al filtration, 0.9 h.v.l., 20 ma., 50 cm. T.S.D.)

Field Treated	Field Size	Dose per Exposure (in air)	Total Air Dose	Interval	Dates
First Course					
Dorsolumbar spine	10 X 20 cm.	200 r	2,000 r	Daily	12/16 to 12/31/41
Ant. rt. upper femur	Open cone	150 r	600 r	Every 2d day	12/22 to 1/2/42
Post. rt. upper femur	Open cone	150 r	600 r	Every 2d day	12/22 to 1/2/42
Second Course					
Dorsolumbar spine	8 X 20 cm.	200 r	1,200 r	2 areas daily	2/3 to 2/20/42
Ant. rt. upper femur	Open cone	150 r	1,200 r	2 areas daily	2/3 to 2/20/42
Post. rt. upper femur	Open cone	150 r	1,050 r	2 areas daily	2/3 to 2/20/42

menstrual periods. She was also hoarse, particularly in the morning.

The patient was admitted to the hospital on Aug. 16, 1937. Physical examination revealed a fullness over the thyroid cartilage and firm enlargement of the right lobe of the thyroid. The basal metabolism rate was -2. A diagnosis of adenoma of the thyroid was made, and on Aug. 17, a hemithyroidectomy was performed, with excision of a right lobe. There was a soft vascular swelling near the median border involving about half the lobe. Within this was a calcified area. Pathological examination showed adenocarcinoma in adenoma. The patient had an uneventful postoperative course and was discharged on Aug. 23, 1937.

She was readmitted on Feb. 21, 1938, complaining of a recurrent nodule on the right side, at the site of the previous lesion. Examination revealed a mass 3 X 3 cm., firm and lobulated, suggesting that it was made up of multiple nodes. Operation on March 1, 1938, revealed a hard mass extending from the stump where the right lobe had been removed into the tissues laterally, and into the sternomastoid muscle posteriorly. Though most of this mass was removed, some neoplastic tissue was left in the region of the stump. On the tenth postoperative day the patient was discharged and referred for radiation therapy. Pathologic examination of the mass showed a histologic picture identical with that of the original specimen.

At the time therapy was instituted several small, stony hard masses were palpable along the right side of the neck in the thyroid region.

The 5-gram radium pack was used, the factors being as follows: distance 6 cm., filtration 0.5 mm. Pt + 5.0 mm. Pb, 8 X 10 cm. portal. Treatment was given to one side of the neck daily for one hour (5,000 mg. hours). Alternate sides were treated between March 10 and April 5, to a total of 50,000 mg. hours to each side. Following treatment a marked erythema developed, but this cleared within a month. During this interval the mass in the right side of the neck became smaller and softer, though there was residual induration.

On May 17, 1938, the patient was readmitted to the hospital and a radium collar was applied. This contained twelve 5-mg., 1.0-mm. Pt tubes with an active

length of 2.2 cm. at 2.5 cm. from the skin. This was left on for forty-eight hours, giving a total of 2,880 mg. hours. During the next six weeks there was further reduction in the size of the mass, and the skin reaction reached an erythema and subsided. The radium collar was reapplied as previously for forty-eight hours from June 22, to June 24, 1938. Following this there was gradual disappearance of the indurated mass and by October 1938 there was no evidence of disease. All that remained was a smooth scar. The patient has been seen at regular intervals and has shown no evidence of recurrence or metastasis. When last seen, in September 1943, she reported that she had recently been married and was well and happy.

#### PROGNOSIS

The prognosis in thyroid carcinoma varies with the histologic structure and the stage of the lesion. The two histologic types which have the best prognosis are fortunately the most common—papillary adenocarcinoma being the most favorable and adenocarcinoma in adenoma second. Pemberton found an over-all survival rate of 77 per cent for operable cases and 29.1 for inoperable cases at three years. The prognosis is, moreover, directly proportional to the classification according to Broders, that for grade 1 being best and for grade 4 worst. According to his group classification, Portmann found 100 per cent of five-year survivals in Group I, 68 per cent in Group II, 23 per cent in Group III, and 3.3 per cent in Group IV. For those receiving postoperative roentgen therapy the corresponding figures were 100 per cent, 65 per cent, 33.3 per cent, and 12.5 per cent. The survival rate among our patients, according to groups, is given in Table IV.



TABLE IV: END-RESULTS IN 64 CASES OF THYROID CARCINOMA

	Stage I	Stage II	Stage III	Stage IV
Number of cases..	3	5	5	51
Known alive under five years.....	..	1	..	..
Survived five to ten years.....	..	..	1	3
Survived ten years or longer.....	1	..	..	2
Known dead.....	..	1	..	32
Presumed dead...	2	3	4	14

## SUMMARY

Sixty-four cases of carcinoma of the thyroid seen in the Radiation Therapy Department of Bellevue Hospital since 1923 are presented. The literature of the subject is reviewed, with a discussion of the pathology and clinical picture. A plan of radiation therapy is offered. Three unusual cases are recorded.

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# Further Problems in X-Ray Protection

## I. Radiation Hazards in Photofluorography<sup>1</sup>

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THE DANGER of excessive exposure to radiation in the operation of diagnostic roentgen equipment has been pointed out by a number of observers (Braestrup, 1; Bell, 2; Quimby, 3; Taylor, 4; the International X-ray and Radium Protection Commission, 5; the National Bureau of Standards, 6; White, Cowie and de Lormier, 7). Most of these reports have been concerned with the radiation hazards associated with roentgenoscopy. It is the purpose of this communication, the first of a series of three, to describe the exposure conditions which are more or less typical of photofluorography. Recommendations for the adequate protection of personnel operating photofluorographic units will be included in the third paper of the series.

The radiation hazards associated with the operation of photofluorographic equipment are particularly severe. The volume of work is often large, sometimes reaching 400 to 800 exposures daily. Furthermore, the quantity of radiation per exposure is considerably greater than that in standard chest roentgenography. Finally, the equipment is often portable and installation is of temporary character, circumstances which are conducive to faulty protective measures.

### EQUIPMENT

The investigations reported in this paper were conducted with one of the photofluorographic units being used by the Tuberculosis Control Division of the U. S. Public Health Service. The unit included a 200-ma. x-ray machine equipped with a rotating anode tube, with a housing constructed of steel and lined with lead; a lead cone extending from the anode hous-

ing limited the primary x-ray beam. Portable V-shaped floor screens containing 1/16-inch sheet lead shielded the operator and positioners. The arrangement of the photofluorograph and protective screens is shown schematically in Figure 1.

Measurements of the quantity of radiation received at various locations about the photofluorographic enclosure were made with a Victoreen ionization instrument employing both 0.25-r and 25-r ionization chambers. Calibration and leakage were checked prior to and during usage, and in most cases a sufficient number of exposures to give at least a half-scale reading were made. It is recognized that there is some question as to the reliability of the readings made with these ionization chambers when radiation of relatively long wave length, such as is customarily employed in diagnostic radiology, is being measured. White *et al.* (7) have investigated this point and have found no serious error in the Victoreen chamber (*i.e.*, no error greater than 10 per cent) in the normal range of x-ray-tube voltages employed in diagnostic radiography.

### MEASUREMENTS WITH 35-MM. AND 14 × 17-INCH TECHNIQUES

To compare the quantity of radiation required for 35-mm. chest photofluorography with that required for ordinary 14 × 17-in. celluloid films, measurements were made by suspending ionization chambers over the chest anteriorly and posteriorly, with the patient standing in the usual position.

With the 35-mm. technic, a series of 8 patients were exposed, their chest diameters ranging from 19 to 26 cm. and aver-

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to result from partial loss of primordial elements, and permanent sterility from complete loss. Since evidence of early germ cell destruction may be seen in animals that receive less than the dose required to produce temporary sterility, it is plain that functional sperm may be produced in the presence of partial irradiation damage. Hence, although the threshold destructive dose for certain immature germ cells may be relatively very low, that for the functional organ may be high. In any case, it is plain that there are dosage levels below which sterility will not be produced.

*Anemia and Leukemia:* Connective-tissue cells in mammalian organisms comprise a complex and important series of cellular elements having important roles in metabolism, immunity, repair, and other functions. Embryologically the various connective-tissue elements arise from the primitive mesenchyme, making it plain that the different blood elements, as erythrocytes, granulocytes, lymphocytes, and megakaryocytes, have a common origin. In normal hemopoiesis, however, different blast forms serve as the parent types for the various blood elements, the mesenchyme as a rule not functioning as hemopoietic tissue. Mesenchyme cells give rise, also, to cartilage, bone, fat, and fibrous connective tissue, but not only are these elements less sensitive to radiation but changes in them have less significant physiologic consequences in the organism. Thus, while the blood and other connective tissues may be closely related from the standpoint of origin, we shall here be concerned only with the blood and lymphoid organs—the reticulo-endothelial system.

The reticulo-endothelial system taken as a whole can, because it forms new cells continuously throughout life, be spoken of as a generative organ in much the same manner as we have spoken of the skin and testis as generative organs. Perhaps the most significant difference, so far as this discussion is concerned, is that the reticulo-endothelial system elaborates a variety of cell types instead of only one. As we shall

see, the developmental relationship and length of life of these various cell types are of importance in dealing with the injurious action of radiation.

When whole body x-ray irradiation is administered to mice, changes in the reticulo-endothelial system are manifested in a variety of ways. Alterations in the peripheral blood may be observed after exposures as low as 50 r. During the first two to four hours after treatment, a slight rise in leukocyte (both neutrophil and lymphocyte) level is manifested. Within eight to twelve hours, however, this changes to a leukopenia, which may persist as long as two weeks or more (36). Differential cell counts disclose that the leukopenia is due mainly to lymphocyte loss. When doses in the range of 5 to 15 r are administered, some evidence of leukocytosis without subsequent leukopenia is obtained. On the other hand, larger doses (200 to 400 r or above) produce evidence of leukopenia without initial leukocytosis, the fall being due to loss of both lymphocytes and neutrophils. Recovery to the normal range occurs, as a rule, in four to eight weeks, if the damage has not been too great. After repeated application of doses of 200 or 400 r, a condition of chronic leukopenia develops. Acute doses of 800 to 1,200 r produce a severe leukopenia within a few hours, and the result is usually fatal within a week or ten days.

It has not been possible, of course, to observe in such detail the changes which take place in human beings. It is known, nevertheless, that in radiation workers who are occupationally exposed to small amounts of radiation daily persistent leukopenia develops, varying from the normal range to levels of 3,000 cells per cubic millimeter of blood or lower, depending on the amount of exposure (37). In such cases the lymphocytes show an increase or a decrease in number depending on the stage to which the injury has progressed. In some cases there is a shift to the left in the differential count, more than the usual number of myelocytes and blast cells being present. Of particular interest are those persons who

show only mild changes and remain in an apparent state of good health. Whether their ability to resist disease and carry out other physiologic activity is impaired is not known.

The histologic changes in mice following comparatively small doses (50 r) are mild but distinct. Nuclear fragmentation and necrosis of cells in the lymph nodes and spleen may be seen within two to four hours after acute exposure of the whole body. At six to twelve hours the cellular debris is accumulated in small clumps, presumably by macrophage cells. At twenty-four hours, all evidence of cellular debris has disappeared, leaving a picture practically indistinguishable from the normal. When doses of 200 to 400 r are administered, the cellular disintegration is more extensive and the clumps of necrotic material at six to twelve hours are more numerous. Again the debris is cleared in twenty-four hours, but in this case there is a noticeable loss or apparent absence of small lymphocytes, leaving a solid mass of reticular tissue. Reappearance of lymphocytes takes place slowly, and at six weeks it is usually difficult to distinguish irradiated from normal tissues. Following still larger doses, destruction of reticular tissue as well as lymphocytes occurs. In these cases, the power of regeneration is impaired and a condition of aplasia may develop.

Loss of cellular elements takes place in the bone marrow as in the lymphoid organs, but with certain variations. Cellular debris and accumulation of destroyed cells are not seen—only thinning of cellular elements. Because of the rigid character of marrow spaces, sinuses develop as the cells disappear. Since the cells which remain show a greater proportion with ring-shaped nuclei, the loss may be regarded as resulting mainly from the destruction of younger forms. Only slight evidence of bone marrow loss can be detected in mice receiving doses of 50 r, but the marrow spaces become practically devoid of cellular elements following 400 r. Recovery of this tissue likewise ensues in a period of four to eight weeks, if the destruction has not been

severe. Such tissue changes may take place with little or no change in the erythrocyte level of the circulating blood.

The action of radiation on the reticulo-endothelial system may be summarized as follows. Radiation acts alike on the cells of the peripheral blood and hemopoietic organs, causing nuclear fragmentation and cell death. This appears to be true irrespective of the size of dose, very small doses producing damage of so slight a degree as to go undetected by the usual means. Small lymphocytes are the first to go, with neutrophils and blast forms following close after. Reticular cells are comparatively much more resistant, and erythrocytes are usually little affected even by excessive exposures. The lack of effect on the erythrocytes may be explained as follows. Since their life is relatively long and the regeneration of bone marrow rapid, it would appear that the latter is able, even after considerable damage, to regenerate fast enough and resume hemopoiesis quickly enough to avoid the development of significant anemias. Also, it seems plain that, in the case of prolonged exposure, the rate of hemopoiesis may be greatly increased if necessary to compensate for continuous heavy loss of hemocytoblasts. The sudden and marked leukopenias may be explained on the basis of the short life of the leukocytes and the fact that, irrespective of location, they appear to be destroyed outright by radiation. In this case leukopenia appears to develop as soon as the leukocyte reserve has been exceeded. A single dose of 50 r applied to the whole body of a mouse has been found adequate to destroy this reserve.

The foregoing observations pertain to relatively acute effects. They are, however, in part, true of the changes which precede the later complications of aplastic anemia and leukemia. The first of these complications appears to develop when the damage to germinal elements has become so severe that satisfactory regeneration cannot occur. Numerous cases of aplastic anemia have been seen in human beings as well as in animals after excessive exposure

to radiation. The second develops coincident with or as a result of the regenerative growth which takes place. A number of experiments are now on record (38-41) showing that the incidence of leukemia in mice can be appreciably increased by whole body exposures to x-rays, and there is one report (42) indicating that in human beings the incidence of leukemia is higher among physicians than among the general population. It does not follow from the latter observation, of course, that radiation was the contributing agent, but since physicians as a group are exposed more to high-energy radiation than the general population, the observation is in accord with the experimental findings in mice.

We may now return to the matter of developmental relationships in connective-tissue elements. If reticular tissues represent the most primitive mesenchyme of the hemopoietic tissues, and the free lymphocytes an intermediate stage between the reticular tissue and the variety of more advanced forms, it would appear that in the skin, testis, and reticulo-endothelial system the parenchymatous cell loss results from two general causes: destruction of primitive cells by the direct action of radiation and loss by further maturation of cells which cannot be replenished. Further, since free lymphocytes are more easily destroyed than the reticular cells, the response in the reticulo-endothelial system is similar to that in the testis, as the most primitive cells are more resistant than those slightly more advanced in development. More careful studies of the skin may reveal that the intermediate stage in this organ is also more radiosensitive.

*Mutations and Genetic Injury:* The discussion to this point has dealt entirely with tissue or organ changes following exposure to radiation. Since tissue changes result largely from cell changes, it is important to consider the nature of cell changes as well. In 1927 it was first shown that the genetic constitution of a cell can be altered by ionizing radiations (43). The first experiments were carried out on the fruit fly, *Drosophila melanogaster*. Adult

males previously exposed to radiation were allowed to inseminate normal virgin females. Offspring obtained from such matings were examined for abnormalities and a considerable number of individuals were found which showed unusual characteristics. Similar results were obtained when ova were irradiated instead of sperm. The changes were of the most diverse types. Some involved eye color, shape of wings, number of bristles, etc., some early development, and still others the first mitotic division after fertilization (44). Since such modifications become fixed in the germ plasm and are passed from parent to offspring through succeeding generations, they are properly termed "mutations." Various cytologic and genetic studies (45-47) have revealed that the cell alterations which give rise to mutational changes consist of chromosome alterations in the form of deletions, translocations, or inversions, and also of gene modifications. Extrachromosomal changes which affect the host organism or even the genetic line may also occur, but it has not been determined whether such changes are of significance or are transmitted indefinitely.

The mutational changes observed in *Drosophila* were induced in germ cells which carried the alterations into the zygote. These alterations were then passed from one cell to another in the developing offspring until finally the new characters were manifested in the adult stage. Some changes induced in this manner occur earlier and cause abnormalities in development or in early cleavage (48-50). When the cell modifications are incompatible with life, and death results, the original chromosomal or gene changes induced by the radiation are "lethal mutations." Abnormal cleavage usually results in early death of the cell or its progeny after a few additional divisions. When the lethal change occurs in the zygote or early cleavage stages of an oviparous animal, the cells simply disintegrate and disappear into the surrounding medium; when they occur in viviparous animals, the embryo is either absorbed or aborted. Changes hav-

ing less immediate effects may result in monster formation, death not occurring until late in development or even after birth.

Radiation-induced mutations may occur in somatic cells just as they do in germ cells (51), but the consequences are very different. If exposure occurs during early embryonic life, the abnormalities produced may be similar to those resulting from injury to the germ cells. If, on the other hand, exposure occurs late in life, somatic cell mutations are not likely to have significant consequences, that is, unless the cells become endowed with powers of unlimited growth. Indeed, this explanation of cancer has not yet been entirely disproved.

Considerable attention has been given to the dose-effect relationship in the induction of radiomutational changes in *Drosophila*. It has been found by numerous investigators (see 52 and 53 for summary) that the reaction is typical of the mass-action law. This suggests that the reaction has no significant threshold and that there is no dose below which mutational changes will not be produced. As will be shown later, the implications of these findings have considerable bearing on the question of tolerance.

*Shortening of Life Span:* Although it has long been known that radiation may produce lethal changes and that the length of life following exposure will vary in a general way with dosage, there has been no systematic attempt to study this relationship until recently (54). Daily doses of 5, 10, 15, 20, and 25 r were administered acutely to the whole bodies of mice five times weekly, from the age of three months until death. It was found that the length of life varied progressively in an inverse relationship to the size of the daily dose, even the animals receiving the smallest daily treatments showing some reduction in longevity. The most appealing explanation of this reaction is that the regenerative capacity of cells is progressively depleted until a point is reached where the organism is unable to regenerate enough cells to sustain life. In such a case, one would expect

to find in the tissues at death about the same degree of destructive changes, irrespective of the size of the daily dose. Histologic studies, however, disclosed that the amount of tissue injury was not uniformly the same in the different animal groups, but rather that it tended to vary directly with the size of the daily dose. Whether the length of life is shortened by daily exposures of 1.0 r or 0.1 r has not yet been ascertained, although extrapolation of the curves suggests this as a possibility.

## DISCUSSION

Several of the more distinct types of roentgen injury have been described, and in a few instances the amounts of radiation required to produce various effects have been given. It is plain from the statements made, however, that the detailed nature of radiation injury in mammalian organisms is as yet very incompletely understood, and also that relatively little is known regarding the threshold doses required to produce the effects now recognized. Under these circumstances, it is difficult to deal with the question of tolerance. Yet in practice, where decisions must be made, it is necessary to examine the facts and formulate opinions based on the most probable results. We shall now consider some of the underlying problems involved.

*Threshold vs. Non-threshold Reactions:* From the evidence at hand, it seems clear that for irradiation-induced changes such as skin ulceration, sterility, and aplastic anemia, there are threshold dosage levels—that is, levels below which such changes are not produced. In this type of reaction one can speak with full justification of tolerance doses, even though the actual amounts of such doses are not precisely known, and rightfully maintain the attitude that a person will be entirely safe if exposures do not exceed these amounts. On the other hand, for changes such as gene mutations, chromosome aberrations, and the outright killing of cells, there is a fair body of evidence indicating that threshold levels do not exist. In such reactions, the effect

appears to result from an all-or-none single-event type of action, such as the bullet-like encounter of an energy quantum with a vulnerable spot in the cell. Thus, for any increment of dosage there must exist certain chances of cell death, the frequency of which varies directly with the dose. In such instances it seems more proper, as we have suggested before (8), to think in terms of "tolerance injury" rather than "tolerance dose." The expression "tolerance injury" implies correctly that acceptance of any tolerance dose, in the case of non-threshold reactions, is entirely arbitrary and based on the amount of injury one is willing to endure. Realizing that certain chances of genetic modification exist so long as any exposure occurs, the procedure in planning tolerance doses would consist simply in deciding on the degree of risk one is willing to accept and the regulation of exposures accordingly. Such procedure would indeed be reasonably simple if information were available concerning the kinds of mutation that occur and if the frequency of occurrence with respect to various increments of dose were known.

*Frequency of Mutation:* It has been shown (55) that for a particular mutation in *Drosophila* which occurs spontaneously in approximately one of every thousand germ cells, the frequency of occurrence is practically doubled by doses of 35 r of x-rays. In other words, the frequency of mutation is increased from one in one thousand to two in one thousand by such a dose. Assuming that genetic injury in human beings might occur at a similar rate, the remoteness of such injury might appear to be so great as to have little significance, since nearly a year would be required to accumulate a dose of 35 r at the rate of 0.1 r per day. The probability of mutation may, however, not be so remote. In the first place, the figure for *Drosophila* pertains to only one kind of mutation, when actually a great variety of types exist, any one of which may have a frequency of occurrence equal to or greater than that for which the figure was given. Of greater importance is the fact that genetic modifica-

tions appear to accumulate not only during the lifetime of an individual (before reproduction) but through succeeding generations. In this way the long-term aspects of the problem become of particular interest.

Whether genetic injury is accumulating more rapidly in human beings exposed to radiation than in those not so exposed is not known, although a few figures suggest this possibility. A questionnaire was circulated among radiologists some years ago by Hickey and Hall (56), requesting information pertaining to the amount of preconception irradiation injury shown in the offspring of radiation workers. These authors stated that of the 377 couples investigated (usually only the husband coming in contact with radiation), 36.6 per cent were sterile. This figure may be compared with 19.7, which is the percentage of white women 15 to 75 years of age (married and unmarried) shown by the 1940 census (57) to be childless. Hickey and Hall stated further that, of the 262 children born to radiologist couples before radiation employment, 2.6 per cent showed some form of abnormality, whereas of the 412 born after such employment, 4.0 per cent showed abnormalities. Among the child-bearing couples, the average number of children per family was found to be 2.2 as compared with 3.0 for other physicians and surgeons living in comparable circumstances. Naujoks (58) made a study of 91 x-ray workers and found the percentage of sterility to be 24.2 per cent, the incidence of abnormalities to be above normal, and the proportion of developmental defectives to be about 4 per cent. Taken as they stand, these results suggest that preconception irradiation injury is already showing in the offspring of human beings. Since, however, so many hazards are associated with the collection of this type of information, the implications arising therefrom must be accepted with considerable reservation.

*Attitude to Be Taken Regarding the Tolerance Dose:* Confronted thus with evidence that for certain types of injury there is no safe threshold of exposure, what atti-



tude should be taken toward the exposure of healthy persons to ionizing radiations? What significance does the present standard of 0.1 r per day have? There are those who fear that 0.1 r per day is a dangerous level of exposure and urge that the permissible exposure be lowered to 0.01 r per day, or to zero if possible. This view is prompted largely by the fact that mutational changes are believed to result in weaknesses rather than in strength and the feeling that a general racial weakening may ensue. There are others who point out that zero exposure can never be obtained, since our bodies are continually subjected to earth and cosmic radiations at the rate of approximately 0.001 r per day. Dropping the present standard by a factor of 10 leaves only a factor of 10 difference between the proposed new standard and the level of exposure to which man has been subjected during his entire evolutionary development. Reasoning thus, one has a tendency to regard lowering of the safety standard by a factor of 10 as being somewhat absurd and to assume an attitude of indifference. A few figures at this point are illuminating.

It has been pointed out by Martland (59) that 1.0 microgram of radium distributed throughout the body of a human being will have fatal consequences in five to fifteen years, by Rajewsky (60) that 0.1 microgram will have a distinctly deleterious though not fatal effect, by the U. S. Bureau of Standards Handbook (61) that 0.01 microgram is considered the tolerance limit in the human body, and by Krebs (62) that the average human body in middle life contains approximately 0.001 microgram of radium (the figure actually given by Krebs was  $7.5 \times 10^{-3}$  grams). Thus, in a general way there appears to be a factor of 10 difference between the lethal level, the injurious level, the tolerance level, and the normal level. These remarkable figures reveal perhaps more clearly than ever before the comparatively narrow range of radiation exposure compatible with life and emphasize the care required in regulating the permissible exposure.

The limits of the protection problem are thus well bracketed. It is plain that some exposure will take place despite all that man can do to prevent it and further that, if the exposure exceeds certain levels, death will result. Where then does the present standard of 0.1 r per day lie on this scale? From a fairly broad background of experience, there is evidence that this amount of exposure will not produce skin ulceration, sterility, or dangerous blood changes. Whether such exposure will contribute to premature aging or how much it will increase the frequency of mutation is not known. On the basis of the figures just presented, there appears to be a factor of approximately 100 difference between the normal amount of radium in the body and the injurious amount. It would be interesting to transform the radium exposures into roentgen doses in order to compare radium and x-ray doses directly. Such a transformation, however, involves so many uncertain assumptions that little significance could be attached to the figures obtained.

Some impression of the roentgen picture, nevertheless, may be gained by piecing together various facts. From the evidence presented, it is plain that 10.0 r per day applied to the whole bodies of mice appreciably shortens their life span, and from extrapolation there is reason to believe that daily exposures of 1.0 r per day may have injurious effects. The effects obtained with these exposures, then, may be considered comparable to the lethal and injurious radium exposures, respectively. The permissible dose of 0.1 r per day of x-rays, which is a factor of 10 less than the injurious dose, would be comparable to the accepted tolerance limit for ingested radium. As indicated above, the level of natural earth and cosmic radiations (0.001 r per day) is only a factor of 100 lower. But in addition to the earth and cosmic radiations, our bodies are continually subjected to the radiation coming from the small amount of ingested radium, which tends to reduce this figure of 100. Thus, on the basis of the figures given, which in-

volve the assumption that the effects in mice and human beings are generally comparable, there is some justification for believing that in the case of x-rays, also, there is roughly a factor of 10 difference between the lethal level, the injurious level, the permissible level, and the normal level. Let it be understood, however, that while these figures may be the best that can be brought forward at this time, they must be considered as exceedingly rough approximations. They serve only as a working guide, suggesting that a factor of 10 difference in exposure to ionizing radiations may have significant biologic consequences.

But irradiation injury is a practical problem. Certain practices must be followed while further knowledge is being obtained. From the figures just presented, it is plain that 0.1 r per day lies intermediate to the normal and lethal irradiation exposures in a range which might reasonably be expected to be safe. Under these circumstances and while the safety problem is being studied, it would seem most expedient to continue with the present standard of 0.1 r per day until good reason is obtained for changing. Certainly an open-minded attitude should be maintained, for, as shown repeatedly in the discussion above, there is reason to believe that some injury may be produced by continuous exposure to 0.1 r per day.

This attitude ignores completely the non-threshold types of injury. At the present stage, however, this seems the only thing to do, for three reasons: (1) It is plain that there is no possible way of avoiding radiation completely. (2) It is not known whether exposures of 0.1 r per day increase the rate of mutation significantly. (3) It is not yet proved that the mutations caused by radiation are predominantly injurious. Regarding the latter, the great concern over long-range racial weakening does not seem entirely justified. Granting that evolution takes place in part by means of mutation and that radiation may increase the frequency of mutation, it does not follow necessarily that all or even most of the mutational changes will be detrimental

to the race. It is important to keep in mind that all living things, including man, have risen to their present evolutionary level despite constant exposure to ionizing radiations coming from earth and cosmic sources. Hence, while it is recognized that radiation can and does cause serious genetic abnormalities and that some of these may contribute to weakness and be perpetuated indefinitely, one must conclude that there are factors not yet fully recognized which act to counteract the accumulation of injurious effects.

All things considered, it would seem that 0.1 r per day is a reasonable safety level of exposure despite its humble origin. This would appear to be true especially for the familiar threshold types of injury and, on the basis of very fragmentary knowledge, to represent a reasonable risk in the case of non-threshold type reactions. Hence, for the time being, it would appear that efforts should be devoted more to maintaining the adopted standard than to changing it. However, in view of the fact that information regarding irradiation injury is accumulating rapidly, the advisability of making some kind of change should continually be kept in mind.

#### SUMMARY

The problem of radiation protection has been reviewed.

It has been recognized (1) that various effects, such as skin ulceration, sterility, anemia, and even death may result from exposure to ionizing radiation in amounts not greatly exceeding those which accumulate in comparatively short periods of time in various laboratories, shops, and clinics; (2) that for such effects there are threshold levels of exposure; (3) that other changes, such as premature aging and neoplasia, may appear long after exposure; (4) that for still other effects, irradiation-induced mutations, there appears to be no threshold level of exposure; (5) that there is roughly a factor of 100 difference between the accepted permissible dose of 0.1 r per day and the cosmic and earth radiation to which everyone is continuously exposed;

(6) that slight changes in the blood picture can be found in apparently normal persons exposed occupationally to small amounts of radiation.

The feeling is expressed that in the absence of more complete information, every effort should be made to prevent exposure intensities exceeding the present accepted permissible level of 0.1 r per day and that an open mind should be maintained toward the necessity of lowering the present level if this is indicated by future developments.

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# Further Problems in X-Ray Protection

## III. Protective Measures in Photofluorography<sup>1</sup>

MILTON I. BIRNKRANT, M.D.,<sup>2</sup> and PAUL S. HENSHAW, Ph.D.<sup>3</sup>

IN VIEW OF THE necessity for protection against stray radiation in photofluorographic units (1, 2), the Tuberculosis Control Division of the U. S. Public Health Service has developed a program of personnel protection which is herein described. In addition to the provision of adequate protective equipment, measures had to be taken to see that such equipment was properly used and that needless exposure was avoided. In doing this it was necessary to take into account the human factor of heedlessness and to see that operators had to take precautions whether or not they wished to do so. These steps having been taken, it was considered essential to determine by physical means whether the protection provided was adequate. Further, in view of the shortcomings of the accepted permissible dose, it was considered advisable to check workers for evidence of injury. It is believed that this program will provide not only the best possible protection but will yield much needed information concerning the problems of exposure and injury.

### PROCEDURES

*Location of Equipment:* Since the photofluorographic equipment in use is of portable type, operators are directed first of all to give attention to its location and arrangement. Airy, spacious rooms, 18 X 20 feet or larger, are desirable. The equipment should be so arranged that the x-ray beam is directed toward an outside wall, preferably toward a window. The x-ray machine should be at least 8 to 10 feet from side walls in order to reduce reflected radiation and provide adequate freedom of movement of patients and operators.

*Alignment:* Operators are instructed to check alignment with 14 X 17-inch films as described in the first paper of this series (p. 565). In order to keep stray radiation at a minimum, the primary x-ray beam should be limited strictly to the field of the fluoroscopic screen. Such beams can be obtained by properly adjusting the position and angle of the extension cone.

*Unnecessary Primary Radiation:* Some primary radiation escapes through the x-ray tube housing but, as shown in the first paper, this is not the most serious source of stray radiation. Occasionally "leaks" occur in the tube housing due to faulty construction, failure to keep all parts in place, etc. Operators are asked to check for leaks with films and to explore the field around the tube in order to know where the intensity is greatest. Holes in the tube housing should be covered with lead (or other adequate absorbing materials) and the beam of primary radiation confined strictly to the area of the fluorographic screen. The fact that a so-called "ray-proof" tube is being used should not lead to a false sense of security, as the lead housing of such tubes is intended to do no more than cut the escaping radiation to a reasonably safe level. Some idea of the quantity and quality of radiation that will escape from ray-proof tubes operated under a variety of conditions has been given recently in a paper by White, Cowie, and de Lorimier (3). From the measurements made with and without the patient in place in front of the fluorographic screen, it was found that the chief source of stray radiation for the usual working conditions was not the tube but the patient (70 per cent). Hence, while it was recognized that a por-

<sup>1</sup> One of three papers accepted for publication in October 1944.

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tion of the stray radiation was of primary character, escaping through the tube housing, this component was considered of minor significance and nothing further was done about screening in the immediate vicinity of the tubes.

*Protective Screens:* Since the stray radiation from all sources was found by measurement to be several times more than 0.1 r for the average working day at various locations where a technician might stand during exposure, lead screens (1.5 mm. thick) were provided. Workers were asked to arrange these so as to shield themselves from radiation coming both from the tube and the patient. Doses received behind the screen have been found by measurement to be well within permissible limits, even for the heaviest daily schedules. Such equipment was provided, however, before it was known that the patient was the chief source of stray radiation. When it was realized that the character of this radiation was necessarily "soft," it became obvious that such heavy lead screens were unnecessary to reduce exposures to the permissible levels. The effective wave length of the stray radiation at a position lateral to and about 1.5 feet from the fluoroscopic screen was measured and found to be approximately  $0.3 \text{ \AA}$ . Hence, since it was necessary for our screens to reduce the intensity no more than five-fold, it became apparent that lead 0.1 to 0.2 mm. thick or iron 0.7 to 1 mm. thick is theoretically sufficient for this purpose.

*The Human Factor:* Screens having been provided, the next problem was to see that they were used and used properly. In an effort to save the split second necessary to get fully behind the screens, or through indifference or unawareness, technicians often hold their heads and a portion of their bodies behind the screen, leaving the remainder of their person exposed (or *vice versa*). So far as certain types of injury are concerned (2), it probably makes little difference which part of the body is irradiated. For this reason, workers are advised never to so much as rest a hand on the outside of a screen during exposures.

In order to protect operators, including the indifferent and careless, the control switch is rigidly fixed in the middle of the rear side of the operator's screen. Similarly, when a positioner makes up part of the working team and a second screen is used, a foot switch (arranged also in the primary circuit) is located behind this screen. Thus, both workers must be in place behind their respective screens before an exposure can be made.

*The Secretary's Desk:* As pointed out previously, a person seated at a desk within a radius of  $10 \frac{1}{2}$  feet from the patient will accumulate radiation which exceeds the permissible level after 600 to 700 exposures. Hence, a screen is also provided for the secretary, or her desk is placed at a greater distance or behind either the operator's or positioner's screen.

*Determination of exposure conditions* by taking repeated and usually closely spaced photofluorograms of some convenient member of the staff has been found often to be a common practice. In a single 35-mm. photofluorographic exposure the subject has been found to receive 0.9 r on the entrance surface, which is more than the permissible dose for an entire week. It is recommended that an aluminum ladder (Weyl, Warren, and O'Neill, 4) or a copper step tablet (Weidman and Kieffer, 5) be used for calibration purposes. Actually such devices should provide even more satisfactory calibrations than the use of human subjects. If photofluorograms of an aluminum or copper scale are taken with equipment which has been standardized and is giving satisfactory results, the films may be used for checking the same equipment or for calibrating new equipment. It is recommended that wire mesh be used for focusing the camera, and lead numbers for centering the primary beam. This source of needless exposure of human subjects to radiation may thus be eliminated entirely. If, however, calibrated films and other material are not available and a human subject must be used, it is better practice to use patients, as they will not be subjected to repeated exposures.

*Actual Exposure of Personnel:* The distribution of radiation in an x-ray room, is not always as expected. Unsuspected factors may act to change the intensity of exposure at different locations. Furthermore, technicians do not always follow instructions designed for their own protection. Hence, it was considered necessary to measure the amount of radiation reaching each technician. This is being done by means of photographic films. Once per month each worker is supplied with a dental film from a common stock. This he is instructed to carry on his person for a period of seven days, at the end of which time he writes his name, together with the inclusive dates and the number of roentgen exposures made during this interval, directly on the film jacket. The film is then returned to the central office, where it is developed in fresh solutions at 68° F. for five minutes and placed on file for future reference. A graduated series of dental films exposed to known amounts of radiation (0.1 r, 0.2 r, etc.) has been prepared in order that comparisons may be made and some idea obtained of the amount of radiation received. As a rough measure, it may be noted that a dental film exposed to 0.7 r is darkened sufficiently to render difficult the reading of news print. While the practice of carrying films has been in use only a short time, it has nevertheless assisted in discovering excessive exposure in a number of instances.

*Search for Injury:* As made clear previously (2), the full safety value of the present accepted standard of 0.1 r per day as a permissible exposure is not fully known. Hence, it has been desirable both as a protective measure and a research procedure to obtain routine blood counts. Each worker has therefore been asked to submit a routine blood report (red cells, white cells, hemoglobin, and differential cell count) each month, along with the exposed dental film. As yet blood changes constitute the most sensitive detectable response to radiation. The following criteria may be listed as evidence of blood injury: a lowered leukocyte level, either a

high or low lymphocyte ratio, and a shift toward less mature granulocytes (*i.e.*, metamyelocytes, myelocytes, and blasts). The hazards of having blood counts made by various technicians are fully appreciated, but it is believed that some useful information may nevertheless be obtained.

Reports thus far have shown little aside from slightly lowered leukocyte levels. Somewhat more than the usual number of individuals showed leukocyte counts in the range of 4,000 to 6,000 cells per cubic millimeter of blood. In view of the fact that such persons appear normal in all other respects, the question is raised as to whether such changes constitute a health hazard. Paterson (6) states that very few healthy subjects present a series of white cell counts averaging less than 6,000, and that radiation workers who have an initial count above 6,000 are showing early signs of overexposure if the number of white cells through a series of counts averages below 5,000. He states further that in his opinion a leukocyte count of 4,000 or lower indicates definite and undesirable exposure injury requiring that some action be taken.

#### SUMMARY

The Tuberculosis Control Division of the U. S. Public Health Service has developed a program of personnel protection in photofluorographic units.

In the main this program consists of (1) provision of adequate protective equipment, (2) taking account of the human factor of indifference, (3) detection of stray radiation reaching each worker, and (4) watching for evidence of radiation injury in each worker.

The protective equipment consists mainly of lead screens so located as to shield workers from the radiation coming from the x-ray tube and the patient. The human factors are handled in part by locating foot and hand switches behind the screens in such a manner as to require the workers to be in proper location when exposures are made. Stray radiation is detected by means of dental films worn by



each worker for a specified period each month. Evidence of injury is sought through routine monthly blood counts.

**ACKNOWLEDGMENTS:** The authors wish to acknowledge indebtedness to Surgeon (R) C. M. Sharp for suggestions and critical review, Dean B. Cowie for suggestions concerning the measurements presented in the first paper, and Henry L. Meyer for valuable assistance in carrying out the measurements.

#### APPENDIX

An educational film strip (55 frames on 35-mm. period film) has been prepared on the subject "X-ray Protection in Photofluorography." A sound record accompanies the film strip and the presentation covers most of the material presented in this series of three papers. The sound strip method has been found to be an interesting and palatable means of disseminating facts and information to medical and technical personnel. The film, together with a suitable projector and sound amplifier, may be obtained

on loan, without cost, from the Tuberculosis Control Division of the U. S. Public Health Service.

Tuberculosis Control Division  
U. S. Public Health Service  
Bethesda, Md.

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# A Teratoid Tumor of the Chest: A Case Report<sup>1</sup>

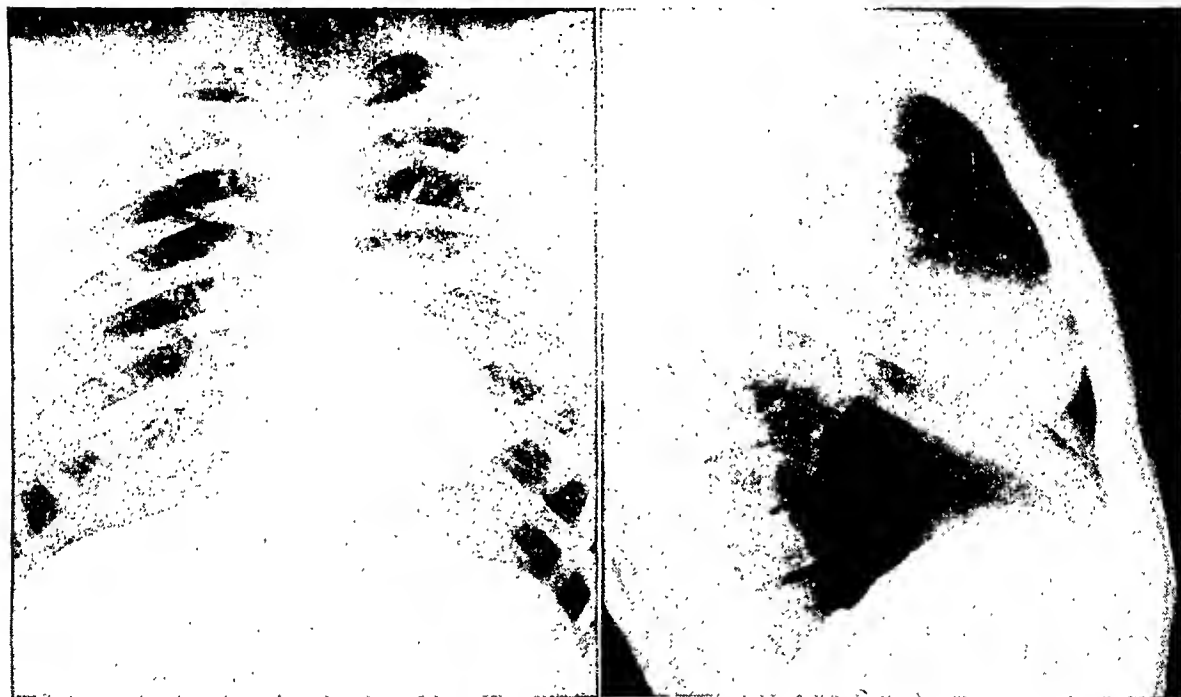
DAVID S. DANN, M.D., IRA H. LOCKWOOD, M.D., HAROLD A. NEIBLING, M.D., and JOHN W. WALKER, M.D.

Kansas City, Mo.

ACCOUNTS of mediastinal masses in the category of "embryonal rest tumors" are becoming more frequent in the literature; yet these cannot be classified as a common tumor. The use of roentgenography as a means of diagnosis has greatly increased the number of recognized cases. Harrington (1, 4) has reported a series of 16

The following case is presented as representative of an anterior mediastinal tumor occurring as an incidental finding rather than to demonstrate the etiology of a clinical syndrome.

A 19-year-old white male who had been doing manual labor two days previously entered the hospital complaining of fever and redness and swelling



Figs. 1 and 2. Roentgenograms of the chest showing tumor and indicating its anterior position.

eases, with correlation of the tumor tissue with the fundamental types. Other authors (3, 5) report isolated examples or smaller series.

These tumors are classified according to the fundamental type of tissue from which they arise, namely ectoderm, endoderm, and mesoderm. They are sometimes designated loosely as dermoids, since they often contain more than one type of embryonal tissue. It has been suggested that the term teratoid is more appropriate.

of the legs. In the past he had been well except for a slight cough occasionally productive of a reddish sputum, mild intermittent pain underneath the sternum, and some dyspnea on exertion. He was a well developed boy with a slightly flushed face. The pupils were equal and reacted to light and accommodation. The tonsils were hypertrophied and red. There was a foul odor to the breath.

Examination of the chest showed the heart apparently enlarged, especially on the left side. The apex was beyond the mid-clavicular line. A murmur was heard obliterating the first sound and was thought to be both presystolic and systolic in time. It was not particularly harsh in character.

Both lung fields were clear and no râles or changes in breath sounds were noted. Examination of the

<sup>1</sup> Accepted for publication in October 1944.

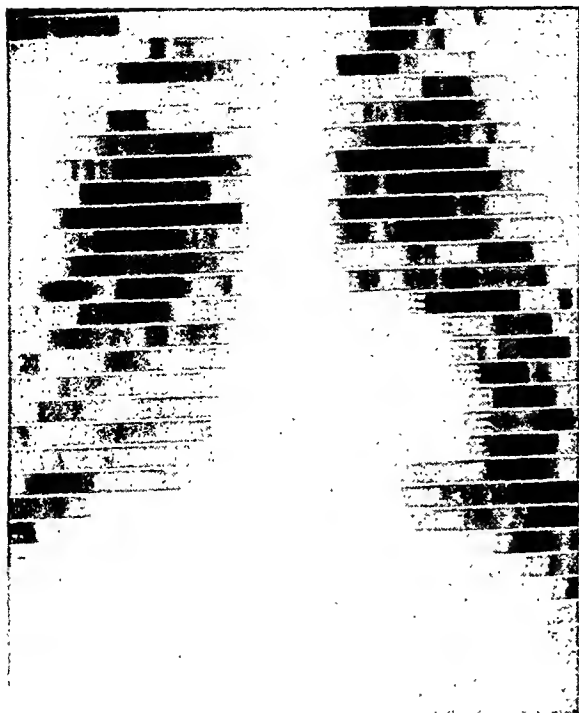


Fig. 3. Kymographic study showing transmitted pulsation.

abdomen was essentially negative. The liver and spleen were not palpable. There was a suggestion of edema of the lower extremities.

The blood pressure was 134/70; temperature, 101.6°; pulse, 105; respirations, 20. The blood showed 13.5 gm. hemoglobin; 12,300 leukocytes with 80 per cent neutrophils and 20 per cent lymphocytes. Blood chemistry: sugar, 105 mg. per cent; creatinine, 1.9 mg. per cent; N.P.N., 37.5 mg. per cent. The albumin was 4.5 gm. per 100 c.c. of blood; globulin, 2.24; fibrinogen, 0.45; total protein, 7.190 with an albumin-globulin ratio of 2.0. Blood cultures on several occasions were negative. The sedimentation rate was 10 mm. in sixty minutes. Urinalyses were essentially negative on several occasions. Subsequent blood studies were within the normal limits except for the sedimentation rate. Seven, ten, fourteen, and twenty-one days after entrance this was 21, 16, 14, and 10 mm., respectively.

Several electrocardiograms showed right axis deviation and the PR interval of one exceeded 0.20 sec.

Postero-anterior and left lateral roentgenograms of the chest showed a well circumscribed homogeneous mass in the anterior thoracic cage, overlying the left heart border. Kymographic study of this mass showed the pulsation along the left border of the heart to be transmitted rather than expansile.

Bronchograms made after the instillation of iodized oil showed that there was neither extrinsic nor intrinsic involvement of the bronchi.

The findings suggested the possibility of a tumor of the anterior mediastinum lying within the cate-

gory of embryonal rest tumors. Hodgkin's or related lymphogranuloma could not be excluded nor could primary or secondary tumor of the pericardium or the myocardium (5).

Bronchoscopic examination revealed evidences of some extrinsic pressure on the lung structures about the region of the juncture of the upper and middle lobes, but no intrinsic lesion was noted. Pulsations about this area were suggestively increased.

An operation was performed after all examinations revealed a tumor which was probably resectable. The left fifth rib was resected, the thorax was entered through the rib bed, and the lung was deflated. An oval tumor about 5 × 9 cm. was found attached to the upper and lower lobes on the left in the interlobar space and to the pericardium adjoining. The mass was freed from the pleura and pericardium by blunt and sharp dissection. Cut section showed a very thin cyst wall; the center of the cyst was filled with an amorphous reddish-brown material. Microscopic examination revealed an unclassified cyst of mesodermal origin.

#### DISCUSSION

Clinically the differential diagnosis of teratoma is difficult, unless the tumor ruptures into a bronchus with expectoration of teratoid products, as hair, teeth, or sebaceous material. Several features, however, are often present. The patient is usually in the younger age group. Dyspnea, *per se*, is not of great diagnostic value, although combined with symptoms of pain it may be of aid. Pain was found in one series (1) to be the chief complaint and is more severe in malignant tumors. Hemoptysis as a symptom may be explained on two bases: it is probably more commonly due to erosion of an air passage by the tumor, but it has been suggested (2, 3) that venous congestion alone, due to tumor size, may result in hemoptysis. In our case, the latter is perhaps the best explanation. Laboratory procedures are of little help.

Correlation of symptoms reveals a patient in the younger age group, complaining intermittently of some retrosternal discomfort and dyspnea, with occasional attacks of hemoptysis, all of which can be tentatively ascribed to a tumor in the mediastinal area.

The roentgen diagnosis of embryonal rest tumors is difficult, if not at times impossible, because their morphological char-

acteristics are so variable. Most authors state that they are more commonly located in the anterior mediastinum than in the posterior and that an anterior mediastinal mass is more likely to produce symptoms than one in the posterior mediastinum.

The size of the mass may vary considerably. That in our case is but a "youngster" compared with those described by Harrington (1), Wheeler (7), Doran and Lester (6). The tumors vary from the size of a small walnut to a mass involving the entire thoracic cage on one side. Occasionally they may be bilateral, the extent of their growth limited only by the thoracic cage. Doran and Lester (6) reviewed the literature and found that they may exceed 7 to 8 kg.

The shape of the tumor also varies. The shadow cast upon the roentgenogram is smooth and well defined but may be obscured by densities caused by pathological reaction of the lung and surrounding structures. This gives an ill-defined shadow or the impression of lung tissue consolidation or even fluid. Wheeler (7) reports a case in which a cystic tumor of this type communicated with the pleural cavity to give the roentgenologic picture of pleural effusion.

Differences in the consistency of the tumors occur, but all have a tendency to cystic change. For this reason the shadow cast upon the roentgenogram may be mottled or homogeneous. Occasionally one might be fortunate enough to see a cyst with a fluid level. The well differentiated types may show teeth or bone, in which event the roentgenogram is diagnostic. However, the radiologist is usually not so fortunate, and the diagnosis will rest on exclusion of other types of tumor.

The differential diagnosis lies among the following conditions: lesions of the lymphogranuloma series and malignant tumors with a tendency toward local invasion; aneurysms; tumors of neurogenic origin; benign lesions of the adjacent or pulmonary structures, such as fibromas or lipomas. Harrington (1, 4) has repeatedly

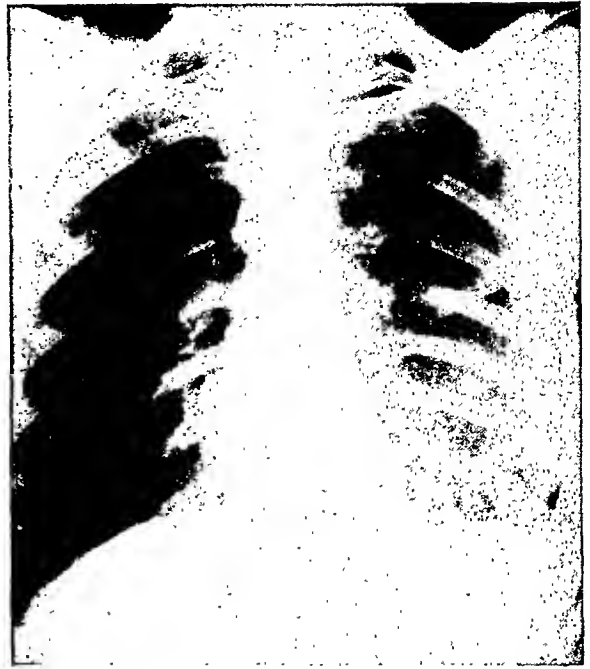


Fig. 4. Roentgenogram of chest after surgery.

emphasized the use of the roentgen ray as a therapeutic test to exclude lymphoblastoma and related diseases. It must also be said that with the increasing tendency to exploratory thoracotomy a valuable means of both early diagnosis and treatment is presented. Mortality rates in selected cases are sufficiently low to make the procedure encouraging.

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# Neurofibroma of the Cauda Equina:<sup>1</sup> Report of a Case

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PRIMARY NEOPLASTIC lesions arising from the spinal cord, nerve roots, and meninges comprise about 15 per cent of all central nervous system tumors. Among 35,000 autopsies in Vienna, Schlesinger (1898) recorded 994 tumors of the central nervous system, of which 151 were spinal cord neoplasms. Ewing (1931) collected 400 spinal cord tumors; out of that number 37, or 9 per cent, were neurofibromas. Peers (1936) found 4 intramedullary spinal cord tumors in 10,592 autopsies. Adson (1939) reported 557 intraspinal neoplasms; 163 of these, or 29 per cent, were neurofibromas. Of 275 spinal cord tumors removed surgically, Elsberg (1941) classified 59 as perineurial fibroma or neurofibroma. Of these, 54 were intradural neurofibromas; only 5 were extradural.

The case to be reported here represents a simple intradural circumscribed neurofibroma originating from the cauda equina, in a young soldier, recognized preoperatively and classified chiefly through the medium of myelography with Panto-  
paque.

Grossly, a neurofibroma is a circumscribed, encapsulated lesion, varying in size, arising from nerve-sheath cells. It may be single or multiple, benign or malignant, simple or plexiform, and may involve either the central or peripheral nervous system. Microscopically, elongated cells are demonstrable, showing a parallel arrangement of their nuclei, called palisading. Occasionally this tumor may show degenerative cystic change. If it arises from the perineurial connective tissue it is called a perineurial fibroblastoma. It may occur at any age, but single lesions are more common in the earlier age group. If it develops within the spinal canal, its symptoms depend on its location, size, and the amount of pressure it exerts on the

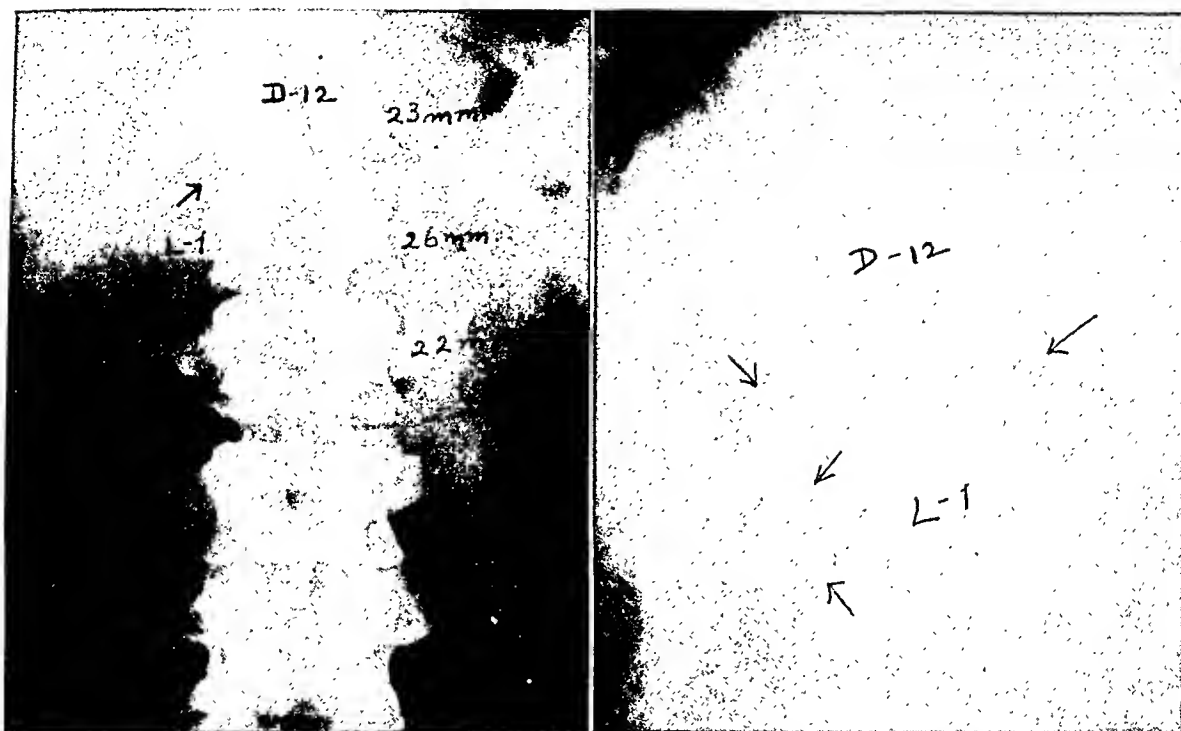
spinal cord or nerve roots. It may be intradural or extradural, may be globular, bulbous, fusiform, or dumb-bell shaped. Neurofibromas of the cauda equina are less common than similar tumors in other parts of the spinal canal. They may occasionally reach large size, producing extensive bone destruction involving several vertebral segments.

## CASE REPORT

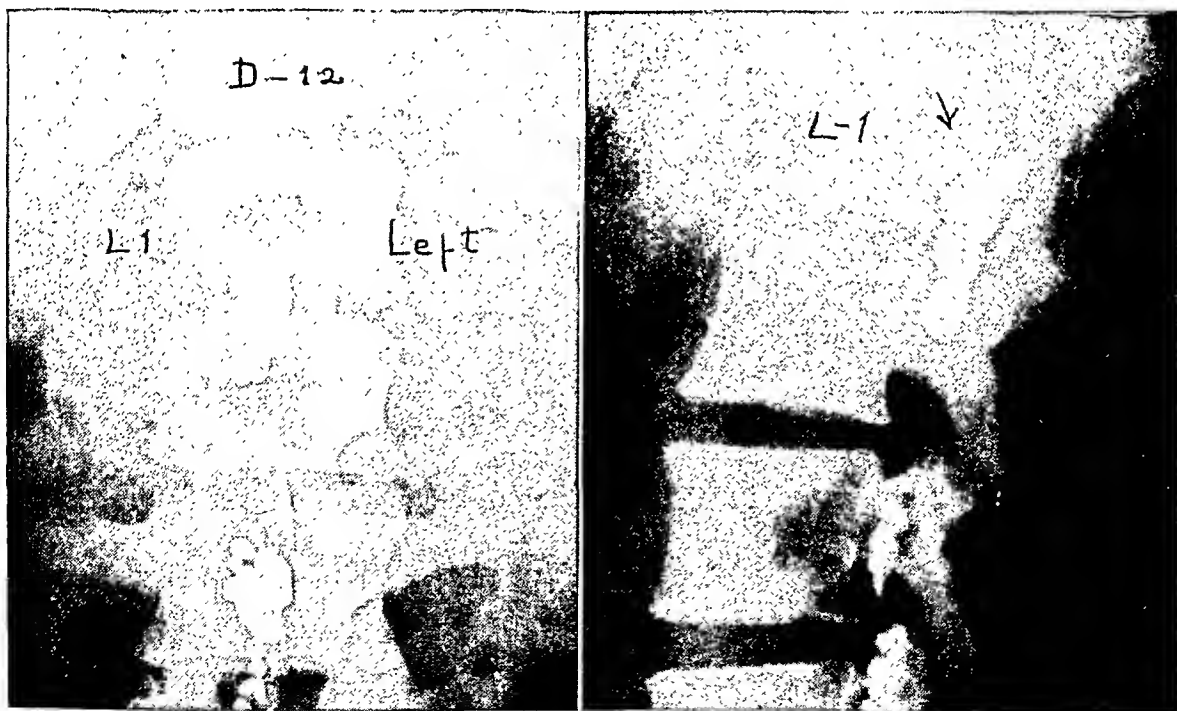
A 23-year-old soldier was inducted into the Army about two months prior to admission to the hospital. Five years earlier, after an effort of lifting, he experienced low-back pain. This had recurred on several occasions following similar effort. Two years before admission a severe attack followed a fall on the back, from a low truck. The attacks lasted two to three weeks, but in the long intervals between attacks the patient was relatively free of discomfort and able to carry on his routine duties on the farm. The attack was in the nature of a severe burning pain in the lumbosacral region, radiating to the right side of the scrotum, and the anteromedial aspect of the right thigh, with inconstant numbness and tingling sensations in the lateral aspect of the right thigh and muscle twitching in that region. The pain was aggravated by twisting and bending movements of the trunk, jarring of the body, and by coughing or sneezing. A few days after induction into the Army, on undertaking required calisthenics the patient experienced an especially severe seizure, completely incapacitating him. He was thereupon admitted to the Neurosurgical Service of Hoff General Hospital, in June 1944, and later transferred to Birmingham General Hospital.

*Physical Findings* (Capt. Edwin R. McKnight, M.C.): The patient, a rather small man, walked with a guarded gait, the head bent forward and the back rigid. His neck showed no deformity, but quick movements of the neck or compression of the internal jugular veins caused excruciating pain in the middle of the lumbar spine (Naffziger's sign). This pain was augmented by sudden release of jugular compression. The spine was rigid; it showed no gross deformity but marked limitation of motion due to muscular spasm. Percussion <sup>1</sup>ness was noted over D-12 and L-1. <sup>1</sup>general weakness of both lower extre- <sup>1</sup>muscle atrophy of both thighs, more pro <sup>1</sup>the right side. Lasègue's sign was <sup>1</sup>sides; Kernig's sign was negative. <sup>1</sup>reflexes of the lower extremities

<sup>1</sup> Accepted for publication in September 1944.



Figs. 1 and 2. Roentgenograms (July 12, 1944) of the dorsolumbar spine. The anteroposterior view (Fig. 1) shows the narrowed disk between D-12 and L-1; a small osteophyte at the caudal aspect of the body of D-12, on the right side; flattening out of the inner borders of the pedicles of L-1; and interpediculate measurement of L-1 of 26 mm. The enlarged lateral view of D-12 and L-1 (Fig. 2) shows the narrowed disk and the concave posterior border of the cortex of the body of L-1.



Figs. 3 and 4. Myelograms with patient in Trendelenburg position. Note the concave obstructive filling defect of the oil column in mid-portion of the body of L-1.

abdominal reflexes were normal on both sides. No pathological reflexes or sensory changes were observed throughout the body. The thorax showed a pigeon-breast deformity, evidently developmental. There was a varicocele on the left side, of moderate size.

**Laboratory Findings:** The spinal fluid, examined June 22, 1944, at Hoff General Hospital, was of xanthochromic appearance, with total protein of 700 mg. per cent. At Birmingham General Hospital, July 11, 1944, the spinal fluid examination revealed 19 leukocytes and 1 erythrocyte; globulin (Pandy test) 4-plus; total protein 4,500 mg. per cent. The Kahn test (July 11) was negative. Blood examination showed 4,000,000 red cells, 8,400 leukocytes, 14 gm. hemoglobin. The urine was negative for sugar and albumin.

**Roentgen Findings** (July 12, 1944): Plain anteroposterior and lateral films of the dorsolumbar region showed a mild kyphosis of the lower dorsal and lack of lordosis of the lumbar spine. The disk between D-12 and L-1 was narrowed (Fig. 1). One small osteophyte was observed at the right lateral border of the body of D-12. The pedicles of L-1 showed mild flattening out of their inner borders. The interpediculate measurement of D-12 was 23 mm.; of L-1, 26 mm.; of L-2, 22 mm. In the lateral view the posterior border of the body of L-1 showed a slight concavity (Fig. 2).

For *myelographic study*, 3 c.c. of Pantopaque were injected at the level of L-4. Fluoroscopic observations of the oil column showed free downward movement of the oil with the patient upright. In the Trendelenburg position, the oil stopped at the level of the mid-portion of the body of L-1. Following removal of the needle, anteroposterior and lateral views taken in the Trendelenburg position (Figs. 3 and 4) showed globulated filling of the right half of the spinal canal. The upper border of the oil column disclosed a concave defect consistent with an obstructive lesion.

**Summary:** The findings as described suggested an intradural obstructive, probably neoplastic, lesion in the spinal canal, on the right side, at the level of L-1, originating from the cauda equina. It was thought that this lesion was probably a small neurofibroma or similar structure.

**Operative Report:** The patient was operated on July 18, 1944, by Lt. Col. David L. Reeves, M.C. The initial incision was made on the right side of the mid-line, over what was thought to be the first lumbar vertebra, but which proved to be at a lower level. The incision was subsequently extended to the level of the spinous process of the 12th thoracic vertebra by means of sharp and blunt dissection and electric cautery. The dura was exposed and seemed to be non-pulsating. The spinous processes of this area were exposed and removed, along with their underlying laminae. This uncovered a bulging area of the dura, the site of the tumor. The dura was opened and a small fibroblastic tumor uncovered.



Fig. 5. Gross specimen. Cut section of the neurofibroma, enlarged one and one-half times.

The tumor was situated on the right side, with nerve roots entering and leaving it. The nerve roots of the cauda equina were sectioned, and the tumor was removed in its entirety. The sectioned nerve roots were approximated with interrupted sutures of fine black silk. The underlying muscles and skin were closed. A small amount of sulfanilamide crystals was sprinkled into the wound prior to closing. The patient tolerated the procedure satisfactorily and left the operating room in good condition.

**Pathological Report** (Capt. Onie O. Williams, M.C.): The gross specimen consisted of an encapsulated mass measuring  $2.3 \times 1.6 \times 1.3$  cm. in its greatest diameters (Fig. 5). The capsule was smooth and appeared to be intact except for one roughened area. On section, the capsule appeared thin. The cut surface was grayish-brown in color and its center showed a dark brown degenerated area suggestive of hemorrhage. Microscopically the tumor was composed of irregularly arranged strands of fibrous tissue having a moderate number of cells and abundant collagen (Fig. 6). Numerous blood vessels were present and interstitial hemorrhage was observed. The cells were uniform in size, of spindle shape, and showed palisading in several areas. No mitotic figures were found.

**Diagnosis:** Neurofibroma of the cauda equina.

**Postoperative Course:** The postoperative course was uneventful. The surgical wound healed in a few days and the patient was able to move about with ease. He was re-examined roentgenographically Aug. 14, 1944, at which time his clinical symptoms had completely disappeared. The x-ray study revealed smooth postoperative defects of the laminae of D-12, L-1, L-2, and L-3. A few residual globules of oil were seen in the spinal canal.



This case demonstrates the importance of myelographic localization of a small intraspinal lesion. Attention is called to the history of multiple traumas, representing a frequent etiological factor. The age of the patient and the clinical findings pointed to a spinal cord tumor, but its definite location and size were doubtful until the myelographic study was made. The com-

to be, most probably, a neurofibroma, since this tumor is not unusual in that area, being next in frequency to the meningiomas. There were no obvious x-ray signs of meningioma in this case. It is evident that the lesion was obstructive, but too small to produce extensive bone destruction or manifold clinical symptoms due to increased intraspinal pressure.

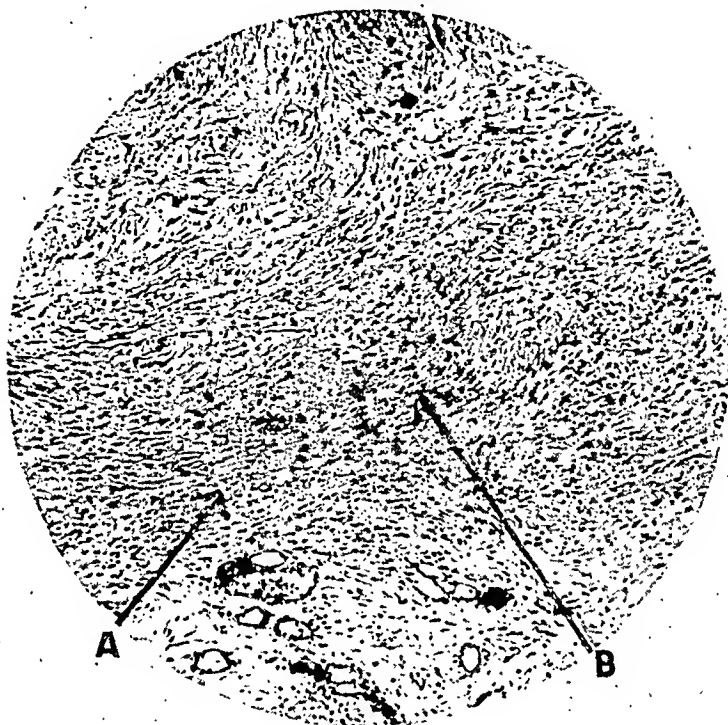


Fig. 6. Section of tumor showing strands of fibrous tissue (A) and cells with palisading (B).

plete obstruction of the oil column and its concave border indicated definitely a circumscribed lesion. Since the pressure erosion changes were mild and confined to one vertebral segment, and since the neurological symptoms were limited, it could be assumed that the lesion was small. Theoretically it would have been possible to visualize the upper border of the lesion by means of injection of another small amount of oil at a higher level, and by taking films in the erect position, outlining the lesion in its entirety. The level of the obstruction at L-1 suggested a lesion originating from the cauda equina. This was thought

#### SUMMARY

A case of neurofibroma of the cauda equina, in a young soldier, has been presented, with clinical, laboratory, myelographic, and microscopic findings. The patient was successfully operated upon and made a complete recovery. Proper correlation of the clinical history and symptoms with the myelographic findings is important in preoperative localization and determination of the size and probable character of these spinal cord tumors.

NOTE: I wish to express my appreciation to Lt. Col. David L. Reeves, M.C., Chief of the Neuro-

surgical Branch of the Birmingham General Hospital, and his Staff for their help and cooperation in preparation of this report.

Birmingham General Hospital  
Van Nuys, Calif.

#### REFERENCES

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# Close-Range Technic in Diagnostic Roentgenology

## Supplementary Note

JULIAN ARENDT, M.D.

Mount Sinai Hospital, Chicago, Ill.

AMONG THE inquiries received concerning "Close-Range Technic in Diagnostic Roentgenology," published in the February issue of RADIOLOGY, was one raising a question as to the safety of such exposures. In view of this, we had the output on our machine (Standard, 4-Valve, Rotating Anode Dynamax) at various voltages and at various distances checked by our physicist, Dr. Robert S. Landauer, who found the r-values to be as set forth in the accompanying table.

These values with the factors given—100 ma. seconds and 1 mm. aluminum filter—demonstrate that no danger is involved if certain rules are observed:

(1) The filter should be 1 mm. aluminum or its equivalent.

RADIOGRAPHIC EXPOSURE INTENSITIES  
(Factors: 100 milliampere seconds; 1 mm. aluminum filter)

Kv.	p.	Roentgens at					
		10 in.	12 in.	14 in.	16 in.	18 in.	20 in.
35		1.15	0.8	0.59	0.45	0.355	0.29
40		1.9	1.3	0.95	0.73	0.58	0.47
45		2.75	1.9	1.4	1.07	0.85	0.68
50		3.75	2.6	1.9	1.5	1.17	0.93
55		4.75	3.3	2.4	1.86	1.47	1.18
60		5.9	4.1	3.0	2.3	1.82	1.48
65		7.2	5.0	3.7	2.8	2.2	1.8
70		8.6	6.0	4.4	3.4	2.67	2.17
75		10.0	7.0	5.2	3.95	3.1	2.52

(2) A 10 to 15-inch cone should be used, attached to the tube.

(3) Close-range technic should not be frequently repeated but should be used selectively for the purpose of demonstrating detail.



## A Service for Radiotherapists

In an editorial appearing in the April issue of *RADIOLOGY*, Professor Mayneord of the Physics Department of the Royal Cancer Hospital (Free), London, called attention to the necessity of close collaboration between the radiologist and the physicist—a collaboration made the more imperative by the rapid advances in radiologic technic.

A concrete example of such collaboration has recently been brought to our attention, in the form of a service organized by the Hospital Physicists' Association of Great Britain, to facilitate the exchange of diagrams and other data (isodose curves, absorption coefficients, etc.) and of books, more especially those of foreign origin, between institutions concerned with radiotherapy.

The idea was inspired by the publication by Professor Mayneord in the *British Journal of Radiology* for December 1943 of a list of x-ray isodose curves, copies of which could be obtained, at the cost of reproduction, from the Royal Cancer Hospital (Free). At a subsequent meeting of the Hospital Physicists' Association, it was suggested that this idea might be extended, under the auspices of that Association, to include not only isodose curves but other diagrams and physical data which

might be useful to radiotherapists. A committee, known as the Diagrams and Data Sub-Committee, was accordingly appointed to organize a scheme for the distribution of such material.

The scheme has now been in successful operation for about a year and a catalogue of items available has been prepared. These include reproductions of graphs and diagrams in a size suitable for practical use, tables of physical data, drawings of apparatus, and a limited list of books which have been made available by members of the Association for borrowing. It is further suggested that, if anyone wishes to obtain material not listed in the catalogue, he address the secretary of the sub-committee, who will endeavor to obtain the desired item. Prices for the service are moderate, and it is planned, as the scheme becomes established, to reduce them still lower.

A letter from Dr. John Read (Radiotherapy Department, London Hospital, Whitechapel, E. 1), Secretary of the Sub-Committee, points to the desirability of extension of the scheme so that it may be international in scope and voices the hope that it may be of use in the reconstruction of radiotherapy in the continental countries of Europe.



## ANNOUNCEMENTS AND BOOK REVIEWS

### NEW HAMPSHIRE ROENTGEN RAY SOCIETY

The latest addition to the roster of state radiological societies is the newly organized New Hampshire Roentgen Ray Society. The officers are: Dr. Fred S. Eveleth of Concord, President, and Dr. Richard C. Batt of Berlin, Secretary-Treasurer.

### COLONEL DE LORIMIER HONORED

For his services as Director of the Department of Roentgenology of the Army Medical School at Washington, from Sept. 8, 1939, to Oct. 1, 1942, Col. Alfred A. de Lorimier has been awarded the Legion of Merit. According to the citation, he "developed an easily transportable, complete and efficient field x-ray equipment for the Army which permits the location of bullets and shell fragments in the body of a wounded man and makes it possible for the surgeon to extract them. He tested all types of roentgenologic materials procured for the Army and formulated the specifications necessary for their purchase. He made extensive studies of the use of photoroentgenography and was instrumental in developing stereoroentgenography, which has a valuable use in induction centers and in mass surveys. By his initiative, original thinking, and development work he has performed outstanding service and contributed materially to the war effort."

RADIOLOGY records with pleasure the well deserved honor to a member of the Radiological Society of North America.

### Letter to the Editor

We are happy to quote here from a letter recently addressed to the Editor by Lieut. Col. Elbert K. Lewis, M.C., A.U.S., Chief of the Roentgenological Services, 297th General Hospital:

"As one of the overseas radiologists having the opportunity to hear the seven excellent lectures on Bone and Joint Radiology (announcement in RADIOLOGY, February 1945) by Dr. James F. Brailsford of England, I wish to express my personal appreciation and gratitude to Dr. Brailsford through the pages of RADIOLOGY.

"I know I speak for many American radiologists to whom these first-rate lectures have been a source of learning and inspiration.

"In addition to these courses, Dr. Brailsford has been most generous with his time and energy in giving scientific presentations on radiological subjects to medical staffs at our hospitals in England.

"American medical officers have enjoyed the hospitality of Dr. and Mrs. Brailsford. At tea parties in their home and beautiful garden, we have

had the exceptional opportunity of knowing, in an intimate atmosphere, the doctor and his charming wife.

"Acts of kindness, such as these, are deeply appreciated by us far away from home."

### Book Reviews

#### RADIOLOGIC EXAMINATION OF THE SMALL INTESTINE.

By ROSS GOLDEN, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director of the Radiological Service, The Presbyterian Hospital, New York. A volume of 239 pages, with illustrations of 183 subjects in 75 figures. Published by J. B. Lippincott Co., Philadelphia. Price \$6.00.

Dr. Ross Golden's monograph, "Radiologic Examination of the Small Intestine," is one of the real contributions to the radiologic literature on a most difficult subject. In his usual way, the author has approached the subject in a thoroughly scientific manner, considering the embryology, the anatomy, and the physiology of the small intestine. He then enters into a description of the roentgen findings in the normal intestine in the infant and the adult. Following that, he considers the organic lesions, such as intestinal obstruction, the use of the Miller-Abbott tube in the diagnosis and treatment of ileus, disorders of nutrition, tumors, diseases of the mesentery, allergy, inflammations, congenital lesions, reflex disturbances, etc.

Dr. Golden has had a tremendous experience in the investigation of the small intestinal tract and he has made every effort to correlate unusual roentgenographic findings with operative and clinical observations, thereby presenting the medical profession with a book that is of real significance. As one reads, one again obtains the impression that the author feels that there is much more work to be done on the small intestinal tract. But to anyone interested in this subject, either from a physiological or a clinical standpoint or from the standpoint of future investigation, a broad basis of scientific consideration can be obtained from this book.

It is a great tribute to Radiology and to the young men who may take up that specialty in the future that they have been provided with such a fundamental book for study and reflection. It should be in the library of every radiologist and clinician interested in the intestinal tract.

The publishers are to be congratulated on the excellence of the paper, the printing, and the illustrations. It is gratifying that in this time of war, with its unavoidable limitations and restrictions, such an excellent piece of work is not spoiled by poor paper and poor workmanship.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

*Section on Radiology, American Medical Association.*—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

## FLORIDA

*Florida Radiological Society.*—Secretary-Treasurer, Charles M. Gray, 306 Citizens Bldg., Tampa 2.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*St. Louis Society of Radiologists.*—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW HAMPSHIRE

*New Hampshire Roentgen Society.*—*Secretary-Treasurer*, Richard C. Batt, M.D., St. Louis Hospital, Berlin.

## NEW JERSEY

*Radiological Society of New Jersey.*—*Secretary*, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

## NEW YORK

*Associated Radiologists of New York, Inc.*—*Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—*Secretary-Treasurer*, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—*Secretary-Treasurer*, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

*Central New York Roentgen Ray Society.*—*Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—*Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—*Secretary*, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

*Rochester Roentgen-ray Society.*—*Secretary*, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—*Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—*Secretary*, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—*Secretary*, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—*Secretary-Treasurer*, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—*Secretary-Treasurer*, Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—*Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—*Secretary*, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

*The Pittsburgh Roentgen Society.*—*Secretary-Treasurer*, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meets second Wednesday of each month at 6:30 P.M., October to May inclusive, at the Ruskin, 120 Ruskin Ave.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary*, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—*Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—*Secretary-Treasurer*, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Dallas-Fort Worth Roentgen Study Club.*—*Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.*—*Secretary-Treasurer*, Asa E. Seeds, Baylor Hospital, Dallas.

## VIRGINIA

*Virginia Radiological Society.*—*Secretary*, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

## WASHINGTON

*Washington State Radiological Society.*—*Secretary-Treasurer*, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—*Secretary-Treasurer*, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—*Secretary*, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.*—*General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.



# ABSTRACTS OF CURRENT LITERATURE

## ROENTGEN DIAGNOSIS

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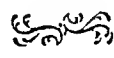
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## THE HEAD AND NECK

Some Roentgenological and Pathological Aspects of Calcification of the Choroid Plexus. Ernest H. Wood, Jr. *Am. J. Roentgenol.* 52: 388-398, October 1944.

The literature on calcification of the choroid plexus is reviewed. Such calcification has been generally considered to be a regressive change and not of pathologic significance. It probably occurs for the most part through a process of proliferation of cells of the pia arachnoid followed by the formation of a dense collagenous and fibrous meshwork in which the calcium is deposited. The extent and location usually are quite symmetrical, but occasionally some degree of asymmetry does occur and calcification may be present only on one side.

Though found most commonly after the age of forty, choroid plexus calcification may occasionally be seen in children. The author reports two such cases in patients aged 2 1/2 and 3 years. In addition to calcification in the glomus (the usual site), there was calcification in the region of the interventricular foramina in each of these children.

Calcification in the choroid plexus of the fourth ventricle has not been described previously but the author reports a case in which such calcification was thought to be demonstrated in the form of a small punctate shadow in the region of this ventricle, remaining unchanged in appearance for six years.

Two cases are also reported to show the significance of displacement of a calcified choroid plexus for the diagnosis of an expanding intracranial lesion. One patient had a tumor in the left occipital region and the other an aneurysm of the basilar artery.

L. W. PAUL, M.D.

Adenoid Bronchsinusitis in Infants and Children. Stewart H. Clifford, Edward B. D. Neuhauser, and Charles F. Ferguson. *M. Clin. North America* 28: 1091-1097, September 1944.

Adenoid bronchsinusitis in infants and children develops as a complication of upper respiratory infection. The infected adenoid tissue and nasal sinuses produce a purulent discharge that obstructs the nasal passage and descends into the trachea and bronchi. In time this postnasal dripping may penetrate the finer bronchi and set up a diffuse peribronchial infection.

The diagnosis of adenoid bronchsinusitis is made by x-ray demonstration of excessive adenoid tissue obstructing the postnasal space. Roentgen examination should include films of the maxillary, frontal, and ethmoid sinuses, and especially a satisfactory soft-tissue film of the nasopharynx, together with fluoroscopy and films of the chest. For the nasopharynx, in a two-year-old child, the technical factors are: distance 40 inches, 1/60 second, 200 ma., 65 kv. The exposure should be made at the moment when the nasopharynx is most apt to contain the maximum amount of air, so that soft-tissue contrast may be obtained. The patient should be breathing through the nose. In an infant the exposure should be made at the very beginning of the cry rather than on full inspiration or expiration. In an older child the best films are obtained while the patient is exhaling through the nose.

The interpretation of roentgen films of the sinuses rarely offers any difficulty except in the very young infant in whom, because of the small size of the ethmoid and maxillary sinuses, it is frequently difficult to recognize minor changes. The usual finding in adenoid bronchsinusitis is irregular thickening of the mucous membrane lining of the paranasal sinuses with or without retained secretions. Adenoid tissue is always excessive and produces a prominent soft-tissue shadow on the posterior nasopharyngeal wall. Frequently this collection of lymphoid tissue is so abundant that the nasopharyngeal airway is all but occluded. The chest films will in all cases show slight prominence of the hilar shadows and considerable accentuation of the bronchovascular markings. In older children the prominent markings are most evident at each lung base, while in the young infant, because of the habitual prone or supine position, the most prominent changes will be in the right upper lobe. Some perivascular congestion is often observed, and occasionally indefinite areas of peribronchial thickening or infiltration. Aeration of the lungs is usually somewhat irregular, with slight peripheral emphysema or localized bulging of one or more of the rib interspaces and occasional areas of lobular diminution in volume. These latter changes are more easily recognized and more frequently observed in the infant chest.

After a three-day course of sulfadiazine, the child's adenoids or tonsils and adenoids are removed. The results are immediate and gratifying.

Fissural Cysts. Harry C. Rosenberger. *Arch. Otolaryng.* 40: 288-290, October 1944.

There are two types of fissural cysts developing at the sites of embryonal fusion of the various processes which unite to form the jaws, one resulting from fusion of the premaxilla and the maxilla, *i.e.*, a cyst of the facial cleft, and the other resulting from the fusion of the palatal process, *i.e.*, a cyst of the incisive canal. A case of each type is presented.

A 52-year-old Negro woman was first seen because of inability to breathe through her left nostril, the vestibule of which was occupied and distended by a globular tumor, producing an asymmetry of the face. The left nasofacial fold was obliterated, and the left upper lip was somewhat protruded. The tumor was soft and fluctuant, though not inflamed, and was limited to the vestibule and the anterior portion of the inferior meatus. The anterior tip of the inferior turbinate was thinned and displaced superiorly against the nasal septum. The superior alveolus was normal, but the globular fluctuant mass was palpable under the lip and just inferior to the piriform aperture. The mass could be moved readily by pressure over the nasal vestibule and counterpressure beneath the upper lip. It appeared to be about 4 cm. in diameter. Roentgen examination of the nose and bony structures adjacent to the left nasal vestibule revealed thinning of the medial bony wall of the left antrum. One of the views showed a sharply defined concavity in the lateral bony wall of the nasal cavity. These findings suggested absorption of bone under pressure. There was no evidence of any formation of a cyst in the alveolus. The cystic mass was removed through a sublabial approach. The diagnosis was nasolabial cyst.

A white man, aged 47, was seen because of a nasal fracture sustained two days previously and a painful swelling in the roof of the mouth of a week's duration, the two conditions being merely coincidental. Examination showed a fractured nose and a firm, tender, inflamed globular swelling about 2.5 cm. in diameter in the mid-line of the hard palate posterior to the alveolus, together with some swelling of the upper lip. It was planned to reduce the nasal fracture and incise the probable abscess of the hard palate. When the patient was seen in the operating room on the following morning, it was found that the abscess had ruptured spontaneously. To provide more adequate drainage, the swelling was incised and a small amount of bloody pus evacuated. At this time the swelling was thought to be caused by an infection of the bone of the hard palate. The floor of the swelling was carefully palpated with a probe to detect any bare rough bone, but none was found. A request for roentgen examination was misunderstood, and only the upper alveolus was reported on; this was normal except for an uninfected retained small tooth fragment. The nasal fracture having been reduced and the swelling of the hard palate having subsided, the patient was discharged. A review of the roentgenograms showed an oval area of decreased density in the mid-line of the hard palate anteriorly. Another roentgenogram taken about a month later also showed an oval smooth area of decreased density about 1 cm. broad and somewhat longer than wide in the anterior mid-portion of the hard palate. The roentgen diagnosis was benign cyst-like area in the superior maxilla. Since operation the patient has had two recurrences of a tender swelling in the anterior portion of the hard palate, but in each instance the swelling disappeared spontaneously, after discharging into the mouth. From the roentgen evidence and clinical course, it seems that the symptoms in this patient were due to a recurring infection of a cyst of the incisive canal. Roentgenograms from this case are reproduced.

### THE CHEST

**Bronchography in Pulmonary Tuberculosis: I.** Normal or Questionable Roentgenographic Findings in Lungs and Positive Sputum. B. A. Dormer, J. Friedlander, and F. J. Wiles. *Am. Rev. Tuberc.* 50: 283-286, October 1944.

Patients are encountered occasionally with sputum persistently positive for tuberculosis but with negative or equivocal chest roentgenograms. The authors report 5 such cases. In all of them iodized oil bronchography revealed sufficient abnormality in the bronchial tree to account for the positive sputum. In several, bronchiectasis involving the upper lobe bronchi was clearly demonstrated. In another case a dilated bronchus leading to a small apical cavity was seen. A complete bronchographic study is recommended for every patient with a positive sputum unaccounted for by adequate roentgen evidence.

L. W. PAUL, M.D.

**Bronchography in Pulmonary Tuberculosis: II.** Radiographic Blackout-Evaluation of Underlying Lesions. B. A. Dormer, J. Friedlander, and F. J. Wiles. *Am. Rev. Tuberc.* 50: 287-292, October 1944.

When a part or the whole of a lung is obscured because of the density produced by a thickened pleura or other pathologic process, evaluation of the underlying

pulmonary disease can be accomplished by iodized oil bronchography. Seven cases are reported in which this procedure was employed to good advantage. The demonstration of atelectasis, bronchiectasis, and cavitation can be a relatively simple matter by this means, especially when body-section roentgenography is not available.

L. W. PAUL, M.D.

**Pathologic Anatomy of "Atypical Pneumonia, Etiology Undetermined." Acute Interstitial Pneumonitis.** Alfred Golden. *Arch. Path.* 38: 187-202, October 1944.

The anatomic lesions of acute interstitial pneumonitis were studied in 21 cases of death from "atypical pneumonia, etiology undetermined." All the cases showed an acute bronchiolitis. The bronchioles were dilated and their walls were infiltrated, chiefly with mononuclear cells, which extended into the peribronchiolar tissues, the alveolar walls, and the pulmonary septa. The chief lesions of the lungs were seen to be comparable to those of certain other infections, notably of influenzal pneumonia uncomplicated by secondary bacterial infection and uncomplicated measles pneumonia. There is anatomic evidence indicating but by no means proving that these lesions are caused by one or more viruses. It is further brought out that some persons dying of the disease succumbed to both acute interstitial pneumonitis and the effects of secondary bacterial infection, as lobular or lobar pneumonia.

A review of the literature shows the essential similarity of the lesions of the lungs in the acute interstitial pneumonia observed in this group of cases to those seen in animals and man in epidemic influenza and in measles. Other investigators who have studied isolated cases of death from this disease in the last ten years have reported pulmonary changes essentially like those described by the author.

Illustrative cases are presented which bring out the anatomic unity of this pulmonary lesion. The features of the lesion are not new, since similar lesions have been described in other diseases. This must not be taken to mean, however, that the disease itself or the etiologic agents have been seen clinically or epidemiologically in the past. Entirely different lines of investigation are required to solve that point.

**Cardiospasm as a Cause of Pneumonitis.** Wm. Gray and I. R. Jankelson. *New England J. Med.* 231: 522-525, Oct. 12, 1944.

In view of the extreme dilatation of the esophagus that may result from cardiospasm, it is not too much to expect that the retained material may spill over into the larynx and lower respiratory tract, causing a pneumonitis. Two new cases are added to those previously reported in the literature.

Radiographically the dilated esophagus may be suspected from an apparent enlargement of the right cardiac border, or possibly a fluid level may be seen in the mediastinum. Examination with barium will establish the diagnosis.

JOHN B. McANENY, M.D.

**Broncholithiasis.** William S. Tinney and Herman J. Moersch. *S. Clin. North America* 24: 830-838, August 1944.

The origin of broncholiths may be endobronchial or extrabronchial. In most instances they arise from

calcified tuberculous peribronchial lymph nodes that gain entrance to the lumen of the bronchus by erosion and ulceration.

Twenty-eight cases of broncholithiasis have been recorded at the Mayo Clinic. The symptoms depend on the size and shape of the calculus, the degree and duration of the bronchial obstruction, and the secondary changes which may take place distal to it in the pulmonary tissue. Cough was a prominent symptom in each of the 28 cases; in 50 per cent it was severe and paroxysmal. An associated asthmatoïd wheeze—so-called "stone asthma"—may be observed. Thoracic pain was an important feature in 13 cases. Hemoptysis usually occurs during or immediately after expectoration of the calculus and was present in 18 cases in this series. Fourteen patients had recurring attacks of chills and fever that were usually diagnosed as influenza or pneumonia.

Whenever there is evidence of an obstructing lesion of the bronchus, a broncholith should be suspected, as well as an aspirated foreign body and bronchiogenic carcinoma. Occasionally, the patient's history and the demonstration of calcification in the roentgenogram of the thorax may lead to a tentative diagnosis of broncholithiasis. Confirmation depends on visualization of the stone in the sputum or at bronchoscopic examination.

In general, the prognosis in cases of broncholithiasis is excellent, particularly if the concretion is expelled spontaneously or removed bronchoscopically soon after the onset of pulmonary symptoms. If the broncholith is not removed or expelled, dangerous sequelae in the form of bronchiectasis or pulmonary abscess are likely to occur. In 10 cases of this series, pulmonary suppuration was secondary to the prolonged bronchial obstruction. In one of this group a fatal metastatic abscess developed in the brain nine months after the onset of pulmonary symptoms.

**Pulmonary Abscess.** Arthur M. Olsen and O. Theron Clagett. *S. Clin. North America* 24: 851-862, August 1944.

Pulmonary abscesses are classified by the authors as simple and complicated, as suggested by Overholt and Rumel (*New England J. Med.* 224: 441, March 13, 1941. *Abst. in Radiology* 37: 515, 1941). A simple abscess may be defined as a solitary cavity in the lung without associated bronchiectasis or pulmonary fibrosis. Such an abscess is usually an early one, observed but a few weeks after its origin. The complicated pulmonary abscess may be multilocular and is characterized by an associated bronchiectasis, pulmonary fibrosis, or empyema. Complications may develop at any stage in the course of pulmonary abscess. Their recognition is important in evaluating the prognosis and in determining the treatment of choice. Adequate roentgenographic studies and bronchograms may be of great assistance.

Aspiration of infected oronasal secretions is the most important factor in the production of pulmonary abscesses. Other basic factors are bronchial obstruction by foreign bodies, bronchial tumors, external bronchial compression, or the so-called mucous plug; disturbance of the physiologic mechanisms of the bronchi and bronchioles; local ischemia of the pulmonary segment.

The early diagnosis of pulmonary abscess is sometimes difficult. Postoperative fever, cough, and

dyspnea should suggest a pulmonary complication, and if the lesion fails to resolve after the usual measures have been taken, an abscess should be suspected. Similarly, pulmonary suppuration should be considered when pneumonia fails to resolve in the customary fashion.

Roentgenographic studies are of the greatest importance in all phases of pulmonary abscess, though in the early stages the roentgen changes alone are not diagnostic, as the pulmonary infiltrates resemble pneumonia, pneumonitis, atelectasis, or infarction. When bronchial communication has occurred, however, a partially filled cavity may be discerned if the films are taken with the patient in the upright position. Adequate roentgenograms are of the greatest importance in localizing the abscess in relation to the thoracic wall when external surgical drainage is contemplated. Stereoscopic films, anteroposterior, lateral and oblique views made with the Bucky diaphragm; and roentgenograms taken in lateral decubitus are all of assistance in localizing the lesion. Roentgenograms should be made at regular intervals until healing is complete. Bronchography made with iodized oil is necessary to detect associated bronchiectasis, before and after treatment. Bronchoscopic examination is desirable in all cases of pulmonary abscess for diagnostic and frequently for therapeutic reasons.

The object of treatment of pulmonary abscess is to provide adequate drainage before complications have developed. Endobronchial drainage will occur spontaneously in 20 to 25 per cent of all cases. When bronchoscopic aspiration is combined with postural drainage and other medical measures, more than half of all pulmonary abscesses may be managed satisfactorily without surgical intervention. External drainage by surgical means should be employed in all cases of uncomplicated pulmonary abscess in which the response to medical management and bronchoscopic therapy is not prompt and adequate. Complicated abscesses do not respond well to either medical or surgical treatment; in selected cases lobectomy or pneumonectomy is indicated.

**Round Densities Within Cavities. Lung Lesions Simulating the Pathognomonic Roentgen Sign of Echinococcus Cyst.** I. D. Bobrowitz. *Am. Rev. Tuberc.* 50: 305-312, October 1944.

Two cases are reported in which roentgenograms revealed an area of homogeneous density within a bronchiectatic cavity in the lung. Lobectomy was done in both. In one the x-ray changes were found to be due to a mass of inspissated pus within a cavity; in the other the density was due to a blood clot. Formerly the appearance of a round mass surrounded by a crescentic air space was considered to be pathognomonic of an echinococcus cyst of the lung. These cases show that other lesions may be responsible for this type of roentgenologic shadow.

L. W. PAUL, M.D.

**Tracheocele.** E. Addington, P. Rusk, and W. Cohen. *Am. J. Roentgenol.* 52: 412-414, October 1944.

Diverticula of the trachea are infrequent and rarely diagnosed clinically. A case is reported in which such a lesion was discovered by roentgen examination in a patient whose chief complaints were episodes of coughing, wheezing, and choking. Bronchography

demonstrated bilateral lower lobe bronchiectasis and a diverticulum in the upper third of the trachea, measuring  $5 \times 4 \times 5$  cm. The lumen of the trachea below the diverticulum was somewhat increased in size. In this case the lesion was considered to be due primarily to a congenital defect in the posterior tracheal musculature with the formation of a diverticulum by increased bronchial pressure produced by coughing.

L. W. PAUL, M.D.

**Arteriovenous Fistula of the Lung: Report of a Patient Cured by Pneumonectomy.** John C. Jones and William P. Thompson. *J. Thoracic Surg.* 13: 357-371, October 1944.

The authors present a detailed report of a case of arteriovenous fistula of the right lung cured by pneumonectomy. This is believed to be only the sixth example of this condition to be reported and the third in which operation was successful.

The patient was a woman of 21, cyanotic from birth and with clubbing of the fingers progressive between the ages of nine and sixteen and stationary thereafter. A year and a half before she was seen by the authors, an intrathoracic mass was discovered by roentgenography, and radiation therapy was given without effect.

Examination revealed a polycythemia, presumably secondary, and a loud rough murmur over the intrathoracic mass. The latter was demonstrable in roentgenograms (including planigrams) as a multilobulated tumor at the base of the right lung, resting on the diaphragm. Superiorly the mass was continuous with large vessels coming from the upper part of the right hilus, believed to be dilated branches of the right pulmonary artery. The tumor appeared to pulsate. The heart was normal. A diagnosis of arteriovenous aneurysm of the lung was made. A pneumothorax was instituted in an attempt to collapse the dilated vessels but proved of no value. At operation, local removal of the aneurysmal mass did not seem feasible and a pneumonectomy was done with excellent results.

On the basis of the cases observed up to the present time, the authors state that arteriovenous fistula of the lung produces a syndrome characterized by cyanosis, clubbing of fingers and toes, symptomatic polycythemia, and symptoms of anoxemia, usually in a young patient with an obscure lung tumor and a normal heart. A continuous murmur may be heard over the tumor.

HAROLD O. PETERSON, M.D.

**Intrathoracic Hodgkin's Disease.** Sidney E. Wolpaw, Charles S. Higley, and Harry Hauser. *Am. J. Roentgenol.* 52: 374-387, October 1944.

A series of histologically proved cases of Hodgkin's disease was studied from the standpoint of intrathoracic involvement and with particular reference to those types of involvement that might be confused with other pulmonary or mediastinal disease. Thirty-five in this series of 55 proved cases showed intrathoracic lesions. These are divided into five groups:

I. *Mediastinal Type.* Mediastinal involvement was the most common, 50 per cent of the cases falling into this category. The roentgen manifestations, which are those of lymph node enlargement, vary with the site and extent of the disease. They are not pathognomonic and may be mimicked by other conditions, so that final diagnosis depends upon biopsy of peripheral nodes or other accessible material.

II. *Parenchymal Type.* Involvement of the lung parenchyma occurred in 40 per cent of the cases and the roentgen changes varied widely. In some the pulmonary infiltrates resulted from direct extension from the mediastinal nodes, occurring as a solid growth into the lung, producing the picture of a massive tumor. In others infiltration extended along the peribronchial and perivascular lymphatics, producing linear or feathery infiltrations on the roentgenogram. Granulomatous consolidation resembling pneumonia was occasionally seen. A less frequent manifestation was the development of circumscribed nodules closely simulating the appearance of pulmonary metastases. Other parenchymal changes occasionally observed were atelectasis and cavitation.

III. *Pleural Type.* Pleural involvement was frequent, occurring as nodular or infiltrating masses on the pleural surface. These lesions may produce massive and persistent effusions, usually serous in nature.

IV. *Osseous Type.* The bones of the thorax may be involved by direct extension of the disease from the mediastinum, lungs, or pleura, and occasionally primary osseous lesions are seen.

V. *Cardiac Type.* The heart is rarely affected except by direct extension from adjacent structures. If it is involved, objective evidence consists of changes in rhythm, size and shape, and evidences of myocardial insufficiency.

Twenty-three of the 35 cases were treated by roentgen irradiation, 17 showing a favorable response after adequate treatment.

Fifteen case histories illustrating the various types of involvement are included, with numerous illustrations.

L. W. PAUL, M.D.

**Intrathoracic Mediastinal Lipoma.** Thomas B. Wiper and Joseph M. Miller. *Am. J. Surg.* 66: 90-96, October 1944.

A case of a completely intrathoracic mediastinal lipoma in a 46-year-old white soldier is reported. The patient was admitted to the hospital complaining of dyspnea and palpitation on exertion. He had gained 35 pounds in weight in the previous two years. Examination of the chest revealed flatness of the left base with absent fremitus and decreased breath sounds which angled off into the left axilla, suggesting a pleural or pericardial effusion.

A roentgenogram of the chest revealed a large soft-tissue mass occupying the lower half of the left lung field and displacing the heart and mediastinum to the right. Fluoroscopy showed a heart of normal size and slight displacement of the esophagus toward the right. A small amount of either obstructive or compressive atelectasis of the lower portion of the left lung was thought to be present. Gastro-intestinal studies were negative. No fluid was obtained on attempted aspiration of the left pleural cavity. A postero-anterior chest film, with the patient in an exaggerated Trendelenburg position, showed the mass in the left mediastinum to "flow cephalad;" films with the patient in the upright position showed the mass to "flow caudally." Roentgen studies after the introduction of 300 c.c. of air into the left pleural space failed to reveal shifting fluid levels. An anteroposterior view with the patient on his right side clearly outlined the costophrenic sinus on the left with a small cushion of air, showing in the contrast film adjacent lung tissue with

the superposition of the smoothly curved border of the mass, both the lung and the mass itself having been separated from the parietal pleura by the intervening air, demonstrating the extrapleural and extrapulmonary situation of the tumor.

The roentgen studies described above, lipiodol filling of the left bronchial tree, bronchoscopy, and other diagnostic procedures revealed but one definite finding—an extrapulmonary mass, extrapleural and quite large in size, impinging upon the bronchus of the left lower lobe, compressing the lower portion of the left wall of the trachea, and producing a moderate degree of atelectasis of the lower left lung. The size of the tumor and the evident good health of the patient militated against a diagnosis of a malignant growth. The anterior position in the chest tended to rule out the commoner types of tumor in the posterior mediastinum. Operation revealed a completely intrathoracic mediastinal lipoma. This was extirpated and, after some postoperative complications, the patient made an excellent recovery.

**Parasternal Diaphragmatic Hernia.** Max Ritvo and O. S. Peterson, Jr. *Am. J. Roentgenol.* 52: 399-405, October 1944.

Parasternal diaphragmatic hernia may result from a failure of fusion of the sternal and costal portions of the diaphragm, the so-called foramen of Morgagni. Even under normal conditions, Larrey's spaces, which correspond anatomically with the foramen of Morgagni, form congenitally weak areas in the diaphragm which may predispose to herniation since deficiencies in the diaphragmatic musculature are normally present in these areas. The incidence of parasternal hernias is low and they are among the least frequently diagnosed hernias. Morton, in 1939 (*Surg., Gynec. & Obst.* 68: 257, 1939), was able to find only 120 reported cases.

Roentgen study of the chest reveals a sharply rounded shadow in the anterior lower lung field adjacent to the right heart border. Such a shadow requires that parasternal hernia be considered the diagnosis until proved otherwise. The density may be uniform if the hernia contains only omentum or fluid-filled gut. If the colon lies within the sac, gas-filled haustrations may be visible. Barium meal and enema studies are of utmost importance in diagnosis. If omentum only is present in the hernia, there are varying degrees of upward and medialward displacement of the right side of the colon. When a loop of the colon is in the hernia, barium filling will lead to the correct diagnosis.

Roentgenograms are reproduced illustrating two cases, details of which are given in the legends.

L. W. PAUL, M.D.

## THE DIGESTIVE SYSTEM

**Roentgenographic Appearance of the Esophagus in Normal Infants.** Harry Bakwin, Eleanor Galenson, and Bernard E. Levine. *Am. J. Dis. Child.* 68: 243-247, October 1944.

The esophagus was studied with the aid of a barium-acacia mixture in 32 infants ranging in age from three weeks to twenty-two months. In all but 4 patients examination was made in the supine position.

Fluoroscopically, the mixture descended the esophagus rapidly in a narrow column, immediately entering the stomach. As the feeding continued, the cardiac

orifice would open and close intermittently. Stasis was then noted, most often in the distal third of the esophagus, with occasional pooling in the proximal as well as the distal third and at times persistent filling of the entire organ. Accumulation of barium produced temporary distention of the esophagus, and several instances of tortuosity were seen. Regurgitation of barium and gas bubbles occurred for a considerable time following the feeding and ranged from partial or complete filling of the esophagus to expectoration.

The roentgen illustrations adequately demonstrate the smooth-walled contours of the esophagus and the various phases of filling described.

LESTER M. J. FREEDMAN, M.D.

**Gastric Carcinoma: Observations on Peptic Ulceration and Healing.** Walter Lincoln Palmer and Eleanor M. Humphreys. *Gastroenterology* 3: 257-272, October 1944.

Ulceration with clinical and pathologic evidence of healing is seen not infrequently in epithelial neoplasms. The process is of particular interest in the stomach because of two problems: first, the difficulty of clinical, roentgenologic, gastroscopic, and even pathologic differentiation between a benign and malignant ulcer; and second, the possibility of neoplastic changes in benign ulcer. Nowhere else in the body is the situation exactly the same because, with few exceptions, tumor tissue is exposed to peptic ulceration only in the stomach.

Four cases are presented, which emphasize the role of peptic digestion in ulceration in pre-existent carcinoma and afford additional evidence of the degree of healing, clinical and pathologic, to be found in such lesions under certain conditions. In none of these cases was there definite clinical evidence of pre-existing benign ulcer. In all of them the duration and the history were compatible with a primary ulcerating neoplasm; gastroscopic evidence of neoplastic infiltration was found in all at the first examination. Pathologically two of the lesions presented in many respects the classical characteristics of a benign ulcer, such as complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer and the presence of a large area of dense fibrous and granulation tissue covered by a necrotic layer. Roentgenograms for 3 cases are reproduced, showing a remarkable decrease in the size of the crater with the healing process, with subsequent increase and recurrence of symptoms.

The authors conclude that certain ulcerating gastric carcinomas may present the architecture characteristic of peptic ulcer. This typical structure is attributed to peptic digestion of the carcinoma and adjacent tissue. In such ulcers there may be marked or even complete repair of the tissue defect. The scar of the ulcer may be covered by neoplastic mucosa or by a layer of epithelium perfectly normal in appearance.

**Varied Clinical Manifestations of Lymphosarcoma of the Stomach.** Henry A. Rafsky, Harry Katz, and Charles I. Kricger. *Gastroenterology* 3: 297-305, October 1944.

Eleven cases of proved lymphosarcoma of the stomach and one probable case are presented. All of the patients came to operation. Their ages ranged from 19 to 80 years. Seven were males.

There was no characteristic history indicating the



presence of the growth. Six patients had symptoms simulating peptic ulcer and even showed temporary improvement on an ulcer regime, but continued to lose weight. Physical examination in most of the patients was not diagnostic. In 4 cases, an abdominal tumor was palpable. Roentgenography resulted in a definite diagnosis of lymphosarcoma in 4 patients and of possible neoplasm in 6 patients. In 2 cases, not examined by the authors, a roentgen diagnosis of gastric ulcer was made.

**Interstitial Ventral Hernia Involving the Small Intestine. Case Report.** William Gray and Moris Horwitz. *Am. J. Surg.* 66: 134-135, October 1944.

Although over 500 cases of interstitial hernia of the inguinal region have been reported, a review of the American literature failed to reveal any cases of ventral hernia of the interstitial type. Such a case in a 64-year-old colored woman is presented. The patient complained of attacks of dull, gripping abdominal pain starting on the right side and spreading over the entire abdomen, with associated nausea. Twenty-two years previously an abdominal laparotomy had been performed and a ruptured peptic ulcer successfully repaired. The patient now noticed that a "hard lump" developed near the old right rectus scar in association with the attacks. Ordinarily, these attacks occurred about once or twice a month and lasted from two to three days.

Examination of the abdomen showed a sausage-shaped, soft mass on the right side, extending from the right iliac crest to the right costal arch. The mass was fixed and moderately tender. A palpable defect in the lower part of the right rectus scar suggested the possibility of a ventral hernia.

X-ray examinations of the gallbladder and kidneys were normal. Barium meal studies of the upper gastrointestinal tract showed no pathological condition involving the stomach or duodenum, but it was noted that a few loops of the small bowel apparently lay on the outside of the abdominal wall. Small-intestinal studies, with films taken three hours following a barium meal, resulted in the diagnosis of interstitial hernia involving the small bowel, for loops of barium-filled small bowel were clearly seen to lie between an apparent split in the muscle sheaths of the right lateral abdominal wall. No obstruction was noted. A barium enema revealed no intrinsic abnormalities involving the colon. Operation confirmed the roentgen diagnosis.

**Diagnosis of Fibrocystic Disease of the Pancreas. Based upon Twenty-Six Proved Cases.** H. F. Philipsborn, Jr., G. Lawrence, and K. C. Lewis. *J. Pediat.* 25: 284-298, October 1944.

Fibrocystic disease is the clinical manifestation of extensive pancreatic cystic fibrosis. The findings in 26 cases studied at necropsy are presented.

Unlike celiac disease, which first becomes apparent during childhood, fibrocystic disease has its inception in infancy. Ordinarily it manifests itself in one of three forms: (a) primarily in respiratory difficulty; (b) primarily in gastro-intestinal disturbances; (c) in a combination of respiratory and intestinal difficulties. The patient is usually under one year of age and often emaciated. The extremities are spindle-like; the abdomen protuberant. The chest is frequently

hyperresonant and the area of cardiac dullness diminished. Auscultation may reveal reduced alveolar air exchanges, with showers of fine moist and sticky râles throughout the chest. Roentgenography has been valuable in diagnosing pulmonary involvement. In far advanced cases with physical findings of emphysema and atelectasis, roentgenograms have often revealed a mottled shadow about the heart accompanied by less dense mottling throughout both lung fields. This picture is considered compatible with multiple lung abscesses, probably of *Staphylococcus aureus* origin.

There is a considerable reduction of pancreatic enzymes in the intestinal lumen. Stools are not necessarily "characteristic" but vary in different individuals and even in the same individual; at one time they may be foul, greasy, and loose; at another time, scybalous, brown, and odorless. The vitamin A curves in patients with fibrocystic disease have been flattened and at all times under 30 units. This, like the hypocholesterolemia, may be only a reflection of poor fat absorption. An elevation in the vitamin A absorption is in direct proportion to the increased intestinal motility.

Treatment of children with fibrocystic disease should be directed toward the pulmonary and gastro-intestinal complications. Bronchoscopic aspirations, postural drainage, vaccines, the sulfonamides, and penicillin are without benefit once pulmonary abscesses have developed. The gastro-intestinal disturbances have been managed by diets high in protein and low in fats. Pancreatic extracts have been administered orally before feedings. Parenteral vitamin A has been given in doses as large as 50,000 units triweekly. This regime in a few instances has produced a favorable response.

## THE SKELETAL SYSTEM

**Acute Manifestations of Yaws of Bone and Joint.** Arthur J. Helfet. *J. Bone & Joint Surg.* 26: 672-681, October 1944.

Yaws is the most common disease of bones and joints in the tropics. While its manifestations are similar to those of syphilis, the author, after eighteen months of observation in West Africa, believes that certain features occur, if not solely, at least more constantly in yaws, thus permitting its differentiation.

Syphilis tends to attack bones and joints slowly and silently. A syphilitic gumma of a joint surface may not cause even muscle spasm or limitation of motion, but in yaws a juxta-articular lesion may simulate arthritis, with joint pain, tenderness, swelling, muscle spasm, and limitation of motion. In the long bones the disease may resemble a septic osteomyelitis, with pain, tenderness, swelling, and fever of a mild degree. The onset may follow trauma and be accompanied by fever with widespread rheumatic pains.

The tibia, lower end of the femur, inner end of the clavicle, and the lower end of the humerus are the sites of election, but other bones may also be attacked. Palmar and plantar skin lesions are rarely present when bone is involved, and the bone lesion seldom ulcerates through the skin.

The radiographic picture resembles syphilis, showing an increase in the diameter of the bone, greatly increased density, and one or several "punched-out" areas. The acute lesion often shows subperiosteal necrosis of the cortex, with raised periosteum and dep-

osition of new bone. The appearance may suggest an osteogenic sarcoma or Ewing's tumor. The roentgenographic picture may change rapidly.

Pathologically the lesion consists of myxomatous-appearing tissue. Where the calcified periosteal layer is raised, it is separated from the bone by a substance of gelatinous appearance. The microscopic section resembles syphilis with round-cell infiltration, many plasma cells, and perivascular cuffing, but there is little endothelial reaction in the blood vessels.

The tendons frequently show ganglia of the same type of tissue that is present in the bone lesions. The joints may show similar growths on the synovia, which are painless and do not seem to attack the cartilage.

The response to arsenicals is dramatic, with roentgen evidence of consolidation in about six weeks.

Reproductions of photographs and roentgenograms are included.

JOHN B. McANENY, M.D.

**Chronic Sclerosing Osteitis (Sclerosing Non-Suppurative Osteomyelitis of Garré). The Differential Diagnosis from Syphilitic Lesions of Bone, Sclerosing Osteogenic Sarcoma, Paget's Disease of Bone (Osteitis Deformans), Subperiosteal Ossifying Hematoma, Osteitis Fibrosa Cystica, Hemangio-Endothelioma (Ewing's Sarcoma, Endotheliomyeloma), and Metastatic Carcinoma.** Henry W. Meyerding. S. Clin. North America 24: 762-779, August 1944.

Chronic sclerosing osteitis is recognized as a form of osteomyelitis. Clinically it is characterized by persistent sharp pain and enlargement of bone. Roentgenologically it shows dense sclerosis usually occurring in the shaft of the tibia or the femur. The roentgenologist and the orthopedic surgeon experienced in diseases of bone usually are able to make a diagnosis from the clinical and roentgen findings. When doubt as to the true nature of the lesion exists, biopsy and a roentgenogram of the thorax (the latter to rule out possible malignant metastases) are indicated.

The differentiation of chronic sclerosing osteitis from syphilitic lesions of bone, sclerosing osteogenic sarcoma, Paget's disease of bone (osteitis deformans), subperiosteal ossifying hematoma, osteitis fibrosa cystica, hemangio-endothelioma (Ewing's sarcoma, endotheliomyeloma), and metastatic carcinoma is discussed. A case of each of the various conditions is reported and illustrated with roentgenograms.

**Simple Roentgenographic Method for the Measurement of Bone Length. A Modification of Millwee's Method of Slit Scanography.** Gerald G. Gill. J. Bone & Joint Surg. 26: 767-769, October 1944.

In order to measure the length of bones accurately, the author has applied a modification of Millwee's slit scanography. The equipment includes a lead plate with a 2-mm. slit across it, that will fit the cone slot in the ordinary radiographic tube holder. A rope is tied to the movable tube stand and through a pulley. A weight is fastened to the other end. The fall of the weight moves the tube stand at an accelerated rate, so that with a constant exposure the thicker part of the bone should be radiographed first and progression made toward the thinner portion. By variation of the radiographic factors, films of good quality can be obtained, and the length of bones can be accurately determined. There is, however, slight distortion of their transverse axes.

JOHN B. McANENY, M.D.

**Collapse of Intervertebral Disc Following Spinal Puncture: Report of Two Cases.** F. Harold Downing. U. S. Nav. M. Bull. 43: 666-673, October 1944.

Two cases showing clinical and radiologic evidence of collapse of the intervertebral disk between L 3 and L 4 following spinal anesthesia are described. The theoretical explanation of such an accident is that the spinal puncture needle is inserted to one side of the mid-line so that it reflects the dura rather than penetrating it. The needle is then forced forward through the annulus fibrosus lateral to its reinforcement by the posterior longitudinal ligament. Since no spinal fluid is obtained, the maneuver may be repeated several times with multiple punctures of the annulus. The nuclear material may escape immediately or the disk may be so injured that it later degenerates and collapses. The author's cases illustrate both possibilities.

To prevent such accidents, it is suggested that a sharp, fine-caliber, short-bevel needle be used and that it be angulated cephalad on insertion so that, if it is inserted too deeply, it will strike the body of the superior vertebra rather than the intervertebral space.

BERNARD S. KALAYJIAN, M.D.

**Triphalangeal Bifid Thumb: Report of Six Cases.** Paul W. Lapidus and Frank P. Guidotti. Arch. Surg. 49: 228-234, October 1944.

The authors report six cases of bifid triphalangeal thumb of varying degrees of development, in two instances hereditary. It is their belief that the extra phalanx represents an abortive stage of polydactyly, or longitudinal splitting of the segment, with assimilation of the extra digit as a single segment of phalanx, rather than a reversion. A schematic system of the various stages from normal to complete longitudinal splitting is presented in the form of a diagram. Photographs and roentgenograms illustrating the six case reports are supplemented by others showing various degrees of bifidism of the digital rays of the extremities. Among these is an interesting film of the feet showing complete splitting of the left second, third, and fourth segments, with the result that the foot had eight complete toes and metatarsals.

LEWIS G. JACOBS, M.D.

**Causes of Failure in the Treatment of Congenital Dislocation of the Hip.** Ignacio Ponseti. J. Bone & Joint Surg. 26: 775-792, October 1944.

Several types of congenital hip dislocation occur: (1) embryonic dislocation, in which the head develops outside of the acetabulum; (2) fetal dislocation occurring during the fetal period; (3) natal dislocation, originating during delivery; (4) postnatal dislocation, the most common type, due probably to some congenital dysplastic condition; (5) subluxation, with a shallow acetabulum and upward displacement of the femoral head but without complete dislocation. The author has used a slightly simpler classification, grouping his cases, 129 in number, merely as prenatal, postnatal, and doubtful.

Determination of the type of dislocation is of importance for both prognosis and treatment, and for this purpose an adequate x-ray examination is of the first importance. In interpretation of the roentgen films it is to be borne in mind that at birth the acetabulum is mostly cartilage. Normally its roof is represented by a dense, slightly concave line, which is the lower border of the ossification center of the ilium.

After the first year, a lighter line appears near the roof, representing the spread of ossification through the anterior or posterior acetabular wall.

In prenatal dislocations, since the head of the femur does not develop in the acetabulum, the acetabular roof is not concave but is flat or convex, and the lighter shadows representing the anterior and posterior walls fail to appear at the end of the first year. The ossification center for the femoral head appears late. A secondary acetabulum is usually well developed after the age of one year, located above the normal one and having no connection with it. Twelve of the author's cases were of the prenatal type.

Postnatal dislocation occurred in 87 of the author's cases. In this group a predislocation stage is usually present at birth, consisting in obliquity of the acetabular roof, delay in appearance of the nucleus of the femoral head, and ectopy of the femoral epiphysis. During this stage the head is still in the acetabulum and may develop normally. Dislocation, if it occurs, takes place slowly and progressively during the entire first year, being well established when the patient begins to walk. The head of the femur slides progressively upward and backward over the surface of the acetabular roof and over the lateral aspect of the iliac wing. In posterior dislocations the roentgenogram shows what the author calls "bilabiation," which appears on the film as an opening of the lateral margin of the ossified acetabular roof for the passage of the femoral head. In anterior and upward dislocations this sign may be absent. In some instances the head of the femur does not pass above the level of the labrum glenoidale, in which case only a subluxation occurs. With complete dislocation a secondary acetabulum develops as an upward prolongation of the primary acetabulum.

The so-called U-shaped shadow formed by the inner and outer surfaces of the medial wall of the acetabulum below the Y cartilage is widened in postnatal dislocations and absent in prenatal dislocations.

Twenty-nine of the author's cases were classified as doubtful, *i.e.*, they could not be placed with certainty in either the prenatal or postnatal group. In these cases the secondary acetabulum was usually well formed and completely separated from the primary acetabulum, while the bilabiation sign was absent.

The significance of the classification of congenital dislocations of the hip is obvious from the results in this series. In none of the 17 cases of prenatal dislocation treated was a normal hip obtained, from which it may be concluded that such dislocations should not be reduced unless the patient is seen during the first months of life. If these cases are left alone a secondary acetabulum will develop which will provide a good functional result. In the postnatal and doubtful cases reduction is indicated. The chief causes of failure in these cases, as determined in this series, were epiphysitis of the femoral head, a tendency to subluxation at the beginning of walking exercises, and osteosclerosis of the acetabular roof. Modifications of treatment to insure better results are outlined.

JOHN B. McANENY, M.D.

**Degenerative Calcification in Articular Cartilage of the Knee.** Paul H. Harmon. *J. Bone & Joint Surg.* 26: 838-840, October 1944.

Two cases of calcification of the articular cartilage of the knee joint are reported.

The first patient was a 75-year-old man who fell, injuring his left leg. A roentgenogram of the knee showed a narrow intra-articular zone of calcification which followed the contour of the articular cortex of the femoral condyles into the recesses of the joint. Death occurred from a urinary tract infection, and sections from the knee joint showed diffuse calcification of the articular cartilage. The menisci were only slightly calcified.

The second patient, a man of 55, was examined for an acute attack of gout, when the articular calcification was incidentally discovered. Linear zones of calcification were demonstrable in both knees and both wrists. Re-examination after two years showed extension of the calcifying process.

This condition is to be distinguished from calcification of the menisci, which is believed to be more common.

JOHN B. McANENY, M.D.

**Congenital Talonavicular Synostosis.** Harold B. Boyd. *J. Bone & Joint Surg.* 26: 682-686, October 1944.

This is a report of 4 cases of congenital talonavicular synostosis, which is rather rare but probably of little clinical importance in itself. However, there is usually an enlargement at the distal end of the navicular on the medial aspect of the foot, which may interfere with the fit of a shoe and become painful. The projection can be removed without difficulty and with resulting comfort to the patient.

The author refers to the review of this subject by O'Donoghue and Sell (*J. Bone & Joint Surg.* 25: 925, 1943. *Abst. in Radiology* 42: 517, 1944).

JOHN B. McANENY, M.D.

**Osteoid Osteoma of Mid-Shaft Region of Femur.** Case Report. Paul H. Harmon. *Am. J. Surg.* 66: 128-131, October 1944.

A case of osteoid osteoma, a non-suppurative, localized benign tumor process composed of osteoid tissue occurring in bones, is described. A 9-year-old girl had experienced intermittent pain in the mid-portion of the right thigh for ten months. Examination showed no positive findings except a fusiform enlargement, definitely palpable, at this site. X-ray studies revealed an area of sclerosis, which appeared as a thickening of the cortical shadow encroaching upon the marrow space. In the center of this thickened sclerotic area in the bone was a radiolucent area approximately 2 cm. in diameter. The roentgen diagnosis was "infection with abscess formation." Curettage was performed and several drill holes were placed through the neighboring reactive bone. The patient made an uneventful recovery and had remained normal for eighteen months following the operation. This case represents the most characteristic site of occurrence of osteoid osteoma, *i.e.*, in the mid-shaft region of a long bone.

**Radiographic Examination of the Ankle Joint Including Arthrography.** F. R. Berridge and J. G. Bonnin. *Surg., Gynec. & Obst.* 79: 383-389, October 1944.

Certain groups of ankle joint injuries require special forms of examination to demonstrate damage to the ligaments. The authors employ, in addition to the usual views: (1) plain radiography in a standard position of both the injured and opposite sides, for comparison; (2) roentgenography under strain, *i.e.*, in the so-called

"position of deformity," with comparable examination of the opposite ankle; (3) arthrography with a contrast medium injected into the ankle joint.

Four positions are recommended for roentgenographic study of the ankle, to be used according to indications in the individual case: (1) anteroposterior, with 10 degrees internal rotation; (2) anteroposterior, with 30 degrees internal rotation, obtained by use of a wooden prism, the head of the first metatarsal and the medial malleolus resting against the prism, with the foot in dorsiflexion; (3) lateral, through both malleoli; (4) lateral with rotation to throw the fibula behind the tibia. For the anteroposterior views the knee should always be in a true anteroposterior position.

The second of the positions listed above, in 30 degrees inversion, is the best to show diastasis of the tibiofibular syndesmosis. This is supplemented by films with the foot externally rotated and dorsiflexed and, in some instances, by arthrography. The authors do not agree with the view held by some that a clear space between the tibia and fibula is indicative of diastasis. They have on several occasions seen such a space at the syndesmosis on either side and attribute it to a shallow tibiofibular groove.

Radiography under strain has proved the most useful method of investigation. It is carried out with the patient under pentothal anesthesia. Since 5 per cent of normal people show relaxation of the fibular collateral ligament, allowing rotation of the talus on inversion of the foot, comparable films of both ankles are necessary when the position of inversion is used. Views under strain are made as follows: (1) inversion, to show rotation of the talus, which may range from 5 to over 45 degrees depending on which ligaments are torn; (2) eversion to show rupture of the deltoid ligament, which results in rotation of the talus in ranges from 10 to 45 degrees depending on the completeness of the lesion; (3) lateral view in plantar flexion, which shows separation of the talus and tibia if both collateral ligaments are torn; (4) anteroposterior projection in 30 degrees inversion with external rotation of the foot, to distinguish between sprains and complete ligamentous rupture.

For arthrography the authors use 3 to 6 c.c. of diodone, such as is used in intravenous urography, injecting it while the patient is still under the anesthetic used for the strain views. The injection is made anteriorly if possible and the joint manipulated to diffuse the medium through the cavity. The usefulness of this technic is limited, but it will demonstrate partial diastasis which the other methods fail to show and it can be used to distinguish between old and recent lesions.

J. L. BOYER, M.D.

**Fractures about the Elbow in Children.** Harold B. Boyd and A. Ralph Altenberg. Arch. Surg. 49: 213-222, October 1944.

*Supracondylar fractures* are the most common fractures about the elbow in children. They constituted about 65 per cent of the authors' series of 713 elbow fractures in patients under twelve years. Even this is considered too low a percentage, as many cases of this type are not hospitalized. The diagnosis can usually be made clinically but should be confirmed roentgenographically, in order to rule out condylar fractures, which demand a different form of treatment. Supracondylar fractures can usually be successfully treated

by closed manipulation. The actual fracture is often less serious than the concomitant damage to nerves and blood vessels. Volkmann's contracture is a serious complication, which should be prevented by careful observation of the circulation at frequent intervals, with release of any constriction.

*Condylar fractures* are fairly common, constituting 25 per cent of this series. They should be treated by immediate open reduction and internal fixation. If this is not done, an overgrowth of the uninjured condyle produces, later in life, either a valgus or varus deformity, a so-called traumatic arthrosis.

*Fractures of the neck of the radius* in children (5% of this series) should be treated conservatively if the head of the radius is in good position; by operative reduction if the position is bad. The radial head should never be removed in a child.

Fracture of the ulna with concomitant dislocation of the radial head (*Monteggia fracture*) constituted 2 per cent of this series; in all fractures of the ulna roentgenographic study of the elbow should be made to rule out this type of injury. In most instances the ulnar angulation can be neglected, as subsequent growth will smooth it out, but accurate reduction of the radial head is important and can usually be secured by closed manipulation. If the dislocation recurs, operative repair with a fascial loop is indicated, and in this case internal fixation of the ulna is indicated.

*Fractures of the olecranon* (1.5 per cent) and *T-fractures of the lower humerus* (0.8 per cent) are rare in children; they usually require open reduction.

LEWIS G. JACOBS, M.D.

**Fatigue-Stress Fractures, Diverse Anatomic Location and Similarity to Malignant Lesions.** J. Gershon-Cohen and Robert E. Doran. U. S. Nav. M. Bull. 43: 674-684, October 1944.

The authors prefer the name "fatigue-stress fracture" for those fractures which follow repeated minor traumatization or over-stressing as in marching. They believe the fractures are similar to those which occur in metals following exhaustion from overloading. The fractures occur far more commonly in the metatarsals than in other bones. Of the metatarsals, the longer second and third often bear an unusual proportion of the stress and are most commonly fractured. Other bones occasionally involved are the tibia, femur, fibula, calcaneus, pelvic bones, humerus, ulna, and spine. The ribs may show similar fractures when cough is present. These fractures occur most commonly, but not invariably, during young adult life.

The extent of fragment separation depends upon the amount of muscle pull. The authors grade the fractures on the degree of distraction of the fragments. Their grade I fractures correspond to what has previously been described as a "march fracture" of the ordinary type. Grades II and III occur under similar circumstances but show many of the characteristics of routine traumatic fractures with immediate production of symptoms and demonstrable fracture lines.

These fractures must be differentiated from spontaneous pathological fractures. Pathologic fractures are usually not related to exercise, are often painless, show a clear broad fracture line and little early callus formation, are frequently multiple, are surrounded by diseased bone, are not limited to weight-bearing bones, and are likely to be associated with systemic disease. Fatigue-stress fractures occur with pain during or

following exercise; callus formation is a prominent characteristic; the fracture line is often ill-defined; the fractures are usually single and involve weight-bearing bones in healthy persons.

BERNARD S. KALAYJIAN, M.D.

**March Fracture. A Report of 307 Cases and a New Method of Treatment.** Abraham Bernstein and Joseph R. Stone. *J. Bone & Joint Surg.* 26: 743-750, October 1944.

This contribution is noteworthy because of the method of treatment that is offered. It consists in the insertion of a metal strip, 1/8 inch thick, 1/2 to 5/8 inch wide, and 6 inches long, beneath the sole of the shoe. The strip is countersunk in the leather and held in place by rivets. A few days are required for the patient to become accustomed to wearing the rigid-soled shoe, but he is soon able to carry on without difficulty, and soldiers can return to their severe training.

The advantage of this treatment is the continued use of the foot. Physiotherapy and hospitalization are unnecessary. After about eight weeks the patient is fully recovered.

JOHN B. McANENY, M.D.

**March Fracture. Statistical Study of 47 Patients.** Darrell G. Leavitt and Harry W. Woodward. *J. Bone & Joint Surg.* 26: 733-742, October 1944.

This is a detailed statistical study of 47 march fractures, showing that the most likely cause is too rapid advance to peak military training before the feet have had sufficient time to become accustomed to the strain. Treatment consists in complete rest for two weeks, after which a plaster cast is applied. Physiotherapy follows and weight-bearing is not permitted until soreness has disappeared.

JOHN B. McANENY, M.D.

**Insufficiency Fracture of the Calcaneus Similar to March Fracture of the Metatarsal.** Clarence W. Hullinger. *J. Bone & Joint Surg.* 26: 751-757, October 1944.

The author reports 53 cases of insufficiency fracture of the calcaneus, in some instances bilateral. These fractures occurred in soldiers in rigid training, most frequently after a cross-country run.

The patient complains of gradually increasing pain in one or both heels for a week or two. Examination shows swelling over the medial and lateral surfaces of the calcaneus, frequently obliterating the malleoli. The swelling disappears after one or two weeks' rest in bed but may recur. Walking is painful, but less so when done on the toes. There is tenderness on pressure over the calcaneus.

Roentgenograms fail to show the fracture until the fifth to eighth week, when an irregular sclerotic line of callus a few millimeters wide is seen extending incompletely through the bone, transverse to the long axis, indicating healing. The diagnosis is made on the clinical findings, since the x-ray evidence is so long delayed.

JOHN B. McANENY, M.D.

## GYNECOLOGY AND OBSTETRICS

**An Antepartum Study of Fetal Polarity and Rotation.** Abner I. Weisman. *Am. J. Obst. & Gynec.* 48: 550-552, October 1944.

This article presents a review of radiographic antepartum studies of 100 unselected primiparous women.

Roentgenograms of the fetus were taken as early as radiopaque shadows could be detected and at regular intervals during gestation. Films made at approximately five months showed 74 cephalic presentations and 26 errors in polarity. At eight months, 19 of the 26 fetuses formerly showing faulty presentation had rotated spontaneously to the cephalic presentation. Six of the remaining 7 were manually rotated by external version. The remaining one was allowed to go to term in breech presentation and delivered by section because of a fibroid blocking the cervix. All the others were delivered normally with the vertex presenting.

The author concludes that repeated radiologic studies are advantageous during the course of pregnancy; that 73 per cent of the errors of polarity will correct themselves by the eighth month; if spontaneous correction has not occurred by the eighth month, it is unlikely to occur after that and external version is often indicated.

HOWARD GUARE, M.D.

## THE GENITO-URINARY TRACT

**Duplication of the Renal Pelvis and Ureter.** Laurence F. Greene. *S. Clin. North America.* 24: 910-921, August 1944.

Duplication of the renal pelvis and ureter is a congenital anomaly in which one kidney is supplied with two pelves and two ureters. The condition may be bilateral. The duplication of the ureter may be complete so that two ureters and two ureteral orifices are present, or incomplete, with one ureter joining the other and with but one ureteral orifice.

A diagnosis of duplication of the pelvis and ureter can usually be made with ease by excretory urography. A roentgenogram made preliminary to the injection of the contrast medium frequently will disclose elongation of the renal outline. After injection, a film will show the duplication. The diagnosis may be corroborated, or arrived at independently, by cystoscopy. Catheterization of each ureter and retrograde pyelography will further establish the diagnosis. Unfortunately, however, these methods are not infallible. Visualization of the renal outline and that of the duplicated pelvis and ureter may be obscured by gas in the bowel or, if a portion of the kidney drained by one of the pelves is diseased, the excretion of contrast medium by that segment may not be sufficient to cast a shadow, with the result that only that pelvis which drains the normal renal segment will be visualized. In this event, an intimation of duplication may be gained from a study of the shape, size, and position of the visualized pelvis. If only the upper pelvis is seen, it usually appears small, with only two major calices; less frequently a single major calix is present, and more rarely three major calices. If only the lower pelvis is visualized, duplication may be suggested by the position of the upper calix, which often, though not invariably, extends chiefly laterally and only somewhat superiorly.

Comparison of the size and position of the visualized renal pelvis with the renal outline may also suggest duplication. The visualized pelvis appears small as compared with the total renal mass and will appear to be situated in either the upper or the lower pole of the kidney. Thus, if the function of the upper segment of the kidney is poor, only the lower pelvis, draining the lower segment, will be visualized by excretory urography. Considerable renal parenchyma with no pelvic outlet

will be noted above the visualized lower pelvis. The converse is true if the lower segment of the kidney is functioning poorly. Cystoscopic examination may disclose but one ureteral orifice on each side. The second ureteral orifice may be overlooked; its appearance may be obscured, as by a ureterocele; or it may be in an ectopic position.

Three cases of duplication of the renal pelvis and ureter in which diagnostic errors were made are presented. Roentgenograms are reproduced.

**Studies Concerning Effects of Calcium on the Urinary Tract.** Harry R. Trattner and Bernard J. Walzak. *J. Urol.* 52: 357-373, October 1944.

The authors studied the effects following intravenous injection of 10 c.c. of a 10 per cent solution of calcium gluconate on the musculature of the renal pelvis and calices, ureter, and bladder in 282 patients. With the aid of a whistle-tip catheter connected to a hydrophorograph—a recording instrument—it was found that peristaltic waves were either considerably reduced in strength or disappeared, and the ureter relaxed to a degree considered to be one of clinical effectiveness in 27 per cent of 45 patients examined following intravenous calcium administration. Bilateral retrograde pyelography showed that injected calcium failed to alter spastic states of the renal pelvis and calices in 17 per cent, of the ureter in 41 per cent, and of the bladder in 30 per cent. Among 20 patients having ureteral colic, pain persisted in 30 per cent.

Excluding instances of slight to moderate relaxation, the injected calcium was found to produce marked relaxation, overcoming a previously existing spastic state, in 30 per cent of the renal pelvis and calices, in 27 per cent of the ureters, and in 57 per cent of the bladders. In 40 per cent of 20 patients suffering from renal or ureteral colic due to stone, there was immediate and complete relief of pain.

From bladder filling determinations before and after calcium injections, it was found that the optimal range of urinary pH in which injected calcium is more apt to produce relaxation lies between 5.0 and 6.5, while increased bladder tone or spasm took place to a greater extent and with more frequency on the alkaline side. The more alkaline the urine, the more likely was this reversal of action to occur.

It was found, also, (1) that urine from the bladder and the right and left sides of the upper urinary tract may be of the same or a different pH; (2) that urine from the painful or infected side of the upper urinary tract was often alkaline; (3) that, excluding such conditions as alkaline cystitis, the pH of bladder urine was sometimes lower than that of urine from the upper urinary tract. When, in the presence of an acid reaction of the bladder urine, the administration of calcium is ineffective for the relief of pain or spasm involving the upper urinary tract, one should bear in mind the possibility that urine issuing from one or both kidneys may be alkaline.

DAVID KIRSH, M.D.

**Rectourinary Fistula.** Seymour F. Wilhelm. *Surg., Gynec. & Obst.* 79: 427-433, October 1944.

This report concerns 18 cases of rectourinary fistula (only one of them in a female). The fistula was due to trauma in 8 cases, to a neoplasm in 6, and to inflammation in 4. It is worthy of note that in every instance the trauma was surgical.

Symptoms consisted in the passage of gas and fecal matter with the urine or the presence of urine in the rectum. Cystitis was usual, unless a check valve existed to prevent passage of feces into the bladder. Diagnosis, aside from physical examination, proctoscopy, and cystoscopy, included the use of colored dyes or radioopaque media for injection. The latter, used with fluoroscopy and radiography, gave valuable aid.

Treatment of the acute cases was by medical means and rest, followed by surgery when needed. The chronic cases were treated surgically in the majority of instances.

EDWIN L. LAME, M.D.

**Retention of Urine in Children Due to Extravesical Pelvic Disease: Report of Two Cases.** Charles P. Howze and Dorothy S. Jaeger. *J. Urol.* 52: 319-325, October 1944.

The authors review the literature and report two cases of urinary retention due to extravesical pelvic disease.

The first patient, a white male child of 3 1/2 years, was admitted to the hospital with abdominal pain of two days' duration. After study, he was discharged with a diagnosis of mesenteric lymphadenitis. Four and a half months later, he was readmitted with urinary retention. A urogram showed bilateral hydronephrosis, and rectal palpation revealed a firm mass filling the lower pelvis. At operation a chronic appendiceal abscess was discovered and removed. Urinary function was restored and recovery was uneventful.

The second patient was a 4-month-old girl, who had been unable to void for the past nine days, requiring catheterization. Three months earlier a number of sacrococcygeal cysts, one of which filled the posterior half of the pelvic cavity, had been removed, but no evidence of malignant growth was seen microscopically. Rectal examination now disclosed a cystic mass the size of a small orange, posterior to the rectum. A urogram showed bilateral hydronephrosis. Seventeen days after admission, an exploratory operation was performed, and a sacrococcygeal cyst covered by posterior pelvic peritoneum was removed. Convalescence was uneventful and postoperative urograms showed a normal upper urinary tract. Pathologically, the mass removed was believed to be a "mixed tumor of spina bifida arising in and separated from the point of origin in the central nervous system at an early stage of embryonic development." N. P. SALNER, M.D.

## THE SPINAL CORD

**Pain Produced by Intraspinal Tumor Simulating Pain Caused by Gallbladder Disease. Report of a Case.** William A. Black. *S. Clin. North America* 24: 893-902, August 1944.

Pain may be the only symptom of early tumor of the spinal cord. It may be confined to the spinal column but more often than not is projected along a nerve root to a localized region of the thorax, abdomen, or extremities. Craig (J. A. M. A. 107: 184, July 18, 1936) states that in 80 per cent of spinal cord tumors pain is the initial symptom and that on an average it is two or more years before signs of compression of the cord appear. In one series of 312 cases, 10 per cent of the patients had been subjected to operation with the hope of relieving pain. A case is presented here in which the



symptoms masqueraded for three and a half years as those of gallbladder disease.

Intraspinal tumors are of two types: extramedullary, arising from the tissues around the spinal cord, and intramedullary, arising in the cord itself. The author's case is of the extramedullary type. The symptoms of extramedullary tumors are divided into three phases—involverment of nerve roots, beginning compression of the spinal cord, and extreme compression of the cord. Intramedullary tumors frequently do not produce pain. And neurologic signs offer the first indication of their presence.

The outstanding symptom of involvement of nerve roots is pain. This is usually lancinating, may be constant or intermittent, and is aggravated by coughing, sneezing, straining, lifting, or any maneuver that increases intracranial pressure. With beginning compression of the cord, neurologic signs become evident, the location of the tumor in relation to the spinal cord determining their character. Severe compression of the cord produces paralysis below the level involved, loss of sensation, trophic disturbances, and loss of control of both vesical and rectal sphincters.

Since pain is a subjective complaint and must be evaluated, a comprehensive and detailed history is necessary in the diagnosis of intraspinal lesions. Seven points which must be considered in each complaint of pain are: situation, depth and projection taken together, frequency, duration, intensity, progress, and associated symptoms. General as well as neurologic examination is necessary, together with spinal puncture, Queckenstedt studies, and roentgenography of the spinal column. Anteroposterior and lateral roentgenograms should be taken, with localized oblique and stereoscopic views of the region where there are clinical signs of tumor. Erosion of parts of the vertebrae due to pressure and invasion of the bone by tumor are sometimes demonstrated, but these changes were not discernible in the roentgenograms in the author's case. Further information, particularly the exact location of the tumor, may be obtained by roentgen studies after the introduction of radiopaque oil. Such studies led to the

diagnosis in the case here recorded, and a degenerating neurofibroma was successfully removed. Intramedullary tumors can be identified by division of the oil into two currents, one on each side of the cord. Because the iodized oil may cause irritation of the meninges and produce a radiculitis, it should be used only when necessary and should be removed at the time of operation.

### THE BLOOD VESSELS

**Primary Axillary Vein Thrombosis: Report of a Case.** Norman H. Bruee. U. S. Nav. M. Bull. 43: 748-753, October 1944.

Primary axillary venous thrombosis occurs chiefly in young males performing heavy duties. A case is reported here to emphasize the importance of venospasm in the syndrome and the wisdom of directing treatment against this phase. The clinical picture usually consists in rapid swelling of the affected arm with some pain, brawny edema, cyanosis, and lowered local temperature. Rest, elevation, immobilization, and diathermy form the usual treatment, with surgical intervention only when these fail. Venography is helpful in determining the site and degree of obstruction. The mechanical obstruction is not the sole cause of the findings, as the vein is often ligated and a section removed in radical mastectomies without serious consequences.

The case here described was typical as to history and clinical findings. A venogram showed a complete block. The patient was treated by application of an elastic bandage and overhead suspension of the arm without improvement. At the end of one week he was given novocain injections in the paravertebral ganglia—stellate and first to fourth dorsal. Within eighteen hours the edema was gone, the color of the arm was normal, and the skin temperature was nearly normal. A venogram seventeen days later showed partial reestablishment of the lumen; another after an interval of eighteen days showed almost complete return to normal.

BERNARD S. KALAYJIAN, M.D.

### RADIOTHERAPY

#### NEOPLASMS

**Treatment of Carcinoma of the Cervix During Pregnancy.** Howard W. Jones, Jr., and William Neill, Jr. Am. J. Obst. & Gynec. 48: 447-463, October 1944.

According to many writers the treatment of choice for cervical carcinoma in the pregnant woman is the emptying of the uterus and irradiation. Others, including the authors of this paper, believe that judicious use of radium may allow carrying the pregnancy to term without too great danger to the mother or the child. Of many reports on this subject, few show five-year end-results for the carcinomas or sufficiently long observation of the children—at least a three-year period—to determine the effects of irradiation.

The authors' study of the literature and 8 cases of their own shows that the chance for production of microcephaly by radium therapy during gestation does not exceed 20 per cent and may be as low as 6 per cent. Among their 8 cases there were 5 children alive and normal at three to fifteen years of age. There were 2

microcephalic children, one of whom died, at four years, of tuberculosis. The eighth child appeared normal but died of measles at eighteen months. There is little evidence in the literature as to the added risk to the mother in carrying pregnancy to term. The authors report 4 patients living and well five years and 1 three years, out of 7 treated during 8 pregnancies. The decision on the course to follow may be influenced by the desire of the parents for a child and their willingness to assume the risk of an abnormal baby.

Treatment started before the fifth month appears to be more hazardous for the fetus than irradiation later in pregnancy. High-voltage x-ray therapy is always contraindicated because of the danger of a substantial depth dose in the region of the developing child. Radium in the cervical canal is also dangerous for the fetus and may initiate labor. The authors use radium tubes held in a cloth plaque against the cervix, employing a large quantity—2.5 to 3 gm.—to shorten treatment time and thus reduce danger of abortion. Dosage must be determined by clinical experience. The dosages in the cases reported here ranged from 1,614 to 3,922



mc. hr. All the patients were delivered by cesarean section. Additional radium and x-ray therapy are given after delivery when indicated.

When carcinoma is discovered after the fetus is viable, cesarean section followed by radiation therapy is indicated. Hysterectomy at the time of section carries a high operative mortality and there is no evidence that it produces better results. Most of the cancers discovered during pregnancy are of Stages I and II. A Stage IV carcinoma usually indicates inadequate prenatal care.

BERNARD S. KALAYJIAN, M.D.

**Uterine Bleeding and the Roentgenologist.** Joe V. Meigs. *New England J. Med.* 231: 549-552, Oct. 19, 1944.

This is a plea for more intensive study of abnormal uterine bleeding before patients are subjected to pelvic irradiation or surgery. Many cases can be cured by proper medication or substitution therapy.

Among the causes of abnormal uterine bleeding, the author mentions changes in the chemical fractions of the blood, a calcium or prothrombin deficiency; blood dyscrasias, as the leukemias or thrombocytopenic purpura; injuries to the sympathetic nervous system; withdrawal of progesterone or estrin; ovarian tumors, more especially granulosa-cell tumors, thecomas, and some cysts; deficiencies of vitamins C, K, and even B; cervical and endometrial polyps and fibroids; pelvic inflammation; cancer of the cervix, endometrium, or fallopian tubes.

In metropathia haemorrhagica, representing the most frequent hormonal pattern of abnormal bleeding, the endometrium is hyperplastic and there is a follicle cyst of the ovary, with a wrinkling of the remainder of the organ and absence of corpus luteum. There may be normal or excessive bleeding, followed by continuous flowing; more frequently a period of amenorrhea precedes a prolonged flow. The condition is seen early or late in the menstrual life. Treatment is with progestin, the corpus luteum hormone.

Other types of hormonal dysfunction should be appropriately treated. Similarly, if the bleeding is attributable to a blood disease, lack of a normal component for coagulation, or a vitamin deficiency, treatment can be undertaken along proper lines. Other cases should be treated with the possibility of a malignant growth in mind, and tissue should be obtained from the cervix and endometrium for histologic study. In the author's opinion radiotherapy has a limited application, since he considers conservation of ovarian function to be most desirable. He especially warns against irradiation in women past the menopause, as this may check the bleeding due to a malignant neoplasm without halting the growth of the tumor, which may then be allowed to go on to an inoperable stage. In women of this group, a curettage should be done. If this fails to reveal the cause of the bleeding and there is a recurrence, the procedure may be repeated. With further recurrence it is best to remove the uterus. X-rays and radium should be reserved for the treatment of bleeding in spinsters near the menopause and for patients in too poor physical condition for operation. Fibroids and benign tumors should be treated by removal of the uterus and cervix with conservation of the ovaries. Cancer calls for surgery, irradiation, or both, according to the indications.

JOHN B. McANENY, M.D.

**A Rapid Radium Implantation Method for Rodent Ulcer.** Alexander A. Charteris. *Am. J. Roentgenol.* 52: 423-430, October 1944.

In a previous article (*Am. J. Roentgenol.* 44: 737, 1940) a method of radium implantation for the treatment of basal-cell carcinoma in the vicinity of the eye was described. The results have continued to be satisfactory, with a high percentage of cures and a low incidence of eye damage. The present report describes a modification of the method whereby the treatment time is compressed into thirty hours, with even better cosmetic results. The needles used have a total length of 15 mm. (5 mm. active length), 0.6 mm. platinum walls, and a radium content of 2 mg. (element). The basic arrangement of implantation is a rectangle 2.5 by 1.0 cm., using six needles. Implantation is carried out as nearly as possible 0.5 cm. below the skin. During treatment the eye is not bandaged and aeriflavine drops (1:1000) are used freely. The skin dose is approximately 3,000 r in thirty hours.

For lesions of the upper lid a thick contact glass is used. This raises the lid almost 0.5 cm. above the globe, thereby reducing the radiation incident on the globe some 50 per cent. In the 5 cases treated thus far, no eye damage has resulted.

A total of 62 patients of all types have been treated since May 1939. There have been only three failures.

L. W. PAUL, M.D.

## NON-NEOPLASTIC CONDITIONS

**Alpha Rays in the Treatment of Wounds.** Erich M. Uhlmann. *Surg., Gynec. & Obst.* 79: 412-418, October 1944.

Radon gas can be readily incorporated in fatty solvents, and in the form of an ointment can be brought into close contact with lesions on the skin surface. Due to the extremely short range of the emitted alpha rays, this form of therapy obviously cannot be applied to malignant tumors.

For the last fifteen years, radon absorbed in neutral fat has been used successfully in treatment of skin changes resulting from destructive doses of radium and x-rays (see *RADIOLOGY* 38: 445, 1942). The author believes that this apparent contradiction is explained by the fact that alpha rays are corpuscular, whereas x-rays and gamma rays are not. More recently, other types of skin lesions characterized by incompetent blood supply have been treated by this method, with equal success. These include Buerger's disease, varicose ulcers, diabetic gangrene, and ordinary burns. Histologic control studies reveal formation of new capillaries about the lesion.

Eight cases are presented. In 4, recurrent skin carcinoma was excised surgically in areas previously injured by irradiation, and healing did not occur until a course of therapy with radon ointment had been instituted. In the remaining 4 cases, there was delayed healing after radical mastectomy and after skin grafting for varicose ulcers. One patient had arteriosclerotic ulcers of the foot not treated by surgery. In every case, healing occurred at an accelerated rate following the application of radon ointment, and the resulting scars are described as remarkably soft and pliable.

The author emphasizes the simplicity of the method and its applicability by any physician who has familiarized himself with it.

JOSEPH SELMAN, M.D.

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